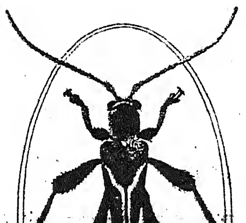
PROCEEDINGS

OF THE

HAWAIIAN ENTOMOLOGICAL SOCIETY

VOLUME XIII
(1947-1949)



HONOLULU, HAWAII

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PROCEEDINGS OF THE Hawaiian Entomological Society

Editor Emeritus, O. H. Swezey

VOL. XIII, No. 1 FOR THE YEAR 1946 MAY, 1947

JANUARY 14, 1946

The 481st meeting was held at the H.S.P.A. Experiment Station on Monday, January 14, at 2:00 p.m., with President Krauss in the chair.

Members present: Messrs. Alicata, Bonnet, Fullaway, Holdaway, Jensen, Keck, Krauss, McBride, Nishida, Pemberton, Rosa, Sakimura, Swezey, Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitors: Messrs. G. F. Augustson, J. V. Benschoter, M. B. Folb, M. S. Johnson, T. B. Murray and C. T. Parsons.

Mr. J. Guy Lewis was elected to membership in the Society.

NOTES AND EXHIBITIONS

Achaea janata (L.)—Mr. Van Zwaluwenburg reported for Mr. Bianchi that during a visit to the island of Lanai, December 14-19, the latter had observed an adult of this agrotid moth at light at Lanai City, a new island record. Mr. Pemberton added that Mr. Look recently told him that the caterpillars of this moth were very abundant in the Kau district, island of Hawaii, stripping *Ricinus* bushes.

Eurytoma attacking *Latrodectus* eggs—It was reported for Mr. Bianchi that a high percentage of eggs of *Latrodectus geometricus* Koch, collected in pineapple fields on Lanai, proved to be attacked by *Eurytoma* sp. This is the first time this wasp has been reported from that island. An almost entirely black variety of *geometricus* was abundant in the Lanai fields, while very few of its brown form were found. No *L. mactans* (Fabr.) were seen.

Litomastix floridana (Ashmead)—Mr. Van Zwaluwenburg reported that caterpillars of *Plusia chalcites* (Esper) parasitized by this encyrtid were recently sent to Iwo Jima. Adult parasites issued en route, and were released on December 28 by R. E. Bertram of the Army's hydroponics unit stationed there.

Thoracaphis fici (Takahashi)—Mr. Zimmerman reported finding, with Dr. Jensen, winged forms of the banyan aphis in Honolulu. This is the first record of winged forms of this species in these islands.

Scotorythra paludicola (Butler)—Mr. Fullaway reported an outbreak of this moth on *Acacia koa* on Maui recently. The caterpillars were heavily parasitized by the ichneumonid *Hyposoter exiguae* (Viereck). He also exhibited a large undetermined prionid beetle reared from logs from the south Pacific, and a recently introduced parasite of the potato tuber moth, *Chelonus phthorimaeae* Gahan, described from Colorado (Proc. U. S. Nat. Mus., **53**: 199, 1917). This parasite is not known to be established here yet.

Anacamptodes fragilaria (Grossbeck)—Dr. Williams reported finding a few caterpillars of this geometrid feeding on soybean foliage in his garden. Mr. Fullaway exhibited specimens of an undescribed species of *Apanteles* parasitic in larvae of *Anacamptodes,* released on Oahu, but not yet established, which Mr. Krauss found in California.

New thrips records from Hawaii—Mr. Sakimura reported the following new island records from Hawaii, all the result of Mr. Look's collecting:

Taeniothrips xanthius (Williams). Hilo; *Cattleya* flowers, etc., Dec. 13, 1945.

Frankliniella fusca (Hinds). Hilo; narcissus flower buds, Nov. 26, 1945. This is also the first record of this species in the Hawaiian Islands. A fairly large colony was found under circumstances which suggest it may have been introduced with narcissus bulbs.

Phlyctaenia rubigalis (Guenée)—Dr. Swezey exhibited a specimen of this pyralid moth reared from celery from California, which was intercepted by Mr. Look at Hilo. The shipment was condemned because of the presence of soil. One caterpillar was found, which Mr. Look reared, the moth issuing November 11. In California it is called the celery leaf-tier, while in the eastern states it is known as the greenhouse leaf-tier. It attacks many kinds of garden and greenhouse plants.

Xystus brassicae (Ashmead)—Dr. Swezey exhibited specimens of this cynipid reared from the cabbage aphid (*Brevicoryne brassicae* [L.]) on Quarantine Island, Honolulu, March 15, 1920, and only recently identified. This is the first record of this parasite in Hawaii. It was described from Florida (U. S. Bur. Ent. Bull, **14**: 14, 1887) as *Allotria brassicae* and was retained in that genus by Dalla Torre and Kieffer in the "Genera Insectorum" (1902). It has a wide range: Florida, Connecticut, New York, Ohio, California and Washington, though few records of its occurrence are to be found in literature. Herrick (Jl. Econ. Ent., **4**: 222, 1911)

mentions *X. brassicae* as an effective parasite of the cabbage aphis. Spencer, however (Ann. Ent. Soc. America, 19:148, 1926), considers it to be a hyperparasite, and demonstrates that it parasitizes the larva of the braconid *Diaeretus rapae* (Curtis). Mr. Fullaway said that he had recorded *Eucoila* sp. ? (Ann. Rept. Hawaii Agr. Expt. Sta. for 1912, p. 29) from *Macrosiphum* sp. and *Aphis sacchari* Zehntner. Some years later he recorded *Eucoila* sp. from *Diaeretus rapae*. (Proc. Haw. Ent. Soc., 8: 115, 1932). Recent examination of the specimen on which this last record is based, shows it to agree with Dr. Swezey's specimens of *X. brassicae*.

FEBRUARY 11, 1946

The 482nd meeting was held at the H.S.P.A. Experiment Station on Monday, February 11, at 2:00 p.m., with President Krauss in the chair.

Members present: Messrs. Bonnet, Faxon, Fullaway, Jensen, Keck, Krauss, Lewis, McBride, Pemberton, Rosa, Sakimura, Swezey, Van Zwaluwenburg, Wirth and Zimmerman.

Visitors: Miss Mabel Chong; Messrs. C. E. Cooley, R. D. Eichman, M. B. Folb, C. P. Hoyt, E. E. Kenaga, R. Z. Pepper and P. W. Weber.

The following resolution was adopted:

Whereas: in the death of Dr. Alastair Martin Adamson on December 24, 1945, the Hawaiian Entomological Society has lost a member of long standing, therefore,

Be it resolved: that the Society hereby records its loss, and expresses its appreciation of his interest in natural science and his contributions to entomology, and

Be it further resolved: that a copy of these resolutions be sent with expressions of sympathy to his bereaved family.

[A biographical sketch, with a portrait, of the late Dr. Adamson appears in *Tropical Agriculture,* January 1946, pp. 3-4].

NOTES AND EXHIBITIONS

Scotorythra paludicola (Butler)—Mr. Fullaway reported further on the recent outbreak of this selidosemid moth on Maui. On February 4 the outbreak in the forest at Waikamoi was estimated to have completely defoliated from 200 to several hundred acres of koa, and another severe outbreak was observed at Kipahula. The broad-leaved variety of koa, introduced from the island of Hawaii, seemed to be little or not at all attacked. Other host plants on which the larvae were feeding were *Tristania* and *Grevillea*. Parasitism by *Hypsoter exiguae* (Viereck) was very heavy, and uniden-

tified birds also were reported feeding on the caterpillars. The infestation is now declining, but it is questionable if the trees will recover from the severe defoliation.

Euscepes postfasciatus (Fairmaire)—Dr. Swezey exhibited a large tuber of the Kuhio vine (*Ipomoea horsfalliae*) heavily infested by the larvae of this sweet potato weevil. This is possibly the first record of this host plant for this weevil.

Achaea janata (L.)—Dr. Swezey reported that Dr. Lyon has brought in a caterpillar of this agrotid moth found hanging by a thread from an avocado tree. When given fresh tender avocado foliage for three days, the larva refused to eat it. It had probably fed upon another adjacent tree rather than on the avocado on which it was found. Further observations on *Achaea* were reported for Mr. Look: The larvae were very abundant and injurious at Pahala, Hawaii during December and January. With few exceptions every castor bean plant was completely defoliated, while "wong bok" cabbage growing at Pahala school was skeletonized within a short time. Larvae were also seen by Mr. Look attacking leaves of *Macadamia,* daikon, cowpea, and *Euphorbia geniculata.*

Volucella sp.—Mr. Van Zwaluwenburg exhibited for Dr. Williams specimens of a new immigrant syrphid fly determined by Dr. Williams as *Volucella* sp. Both sexes were taken February 3, 1946 on blossoms of *Dracaena* in Dr. Williams' garden on Keeaumoku St., Honolulu, at about 6 p.m. of a heavily overcast, sultry day, when *Plusia* and other moths were already on the wing. Ten specimens were taken in fresh condition, and show some variation in intensity of coloration.

Latrodectus sp.—Mr. Keck remarked on the unusual abundance of black widow spiders about bee hives at Ft. Shafter, Honolulu, recently, when three or more spiders could be found under every hive stand.

Lema trilineata californica Schaeffer—Mr. Krauss reported finding an adult of this chrysomelid beetel in October at Riverside, Calif., on "tolguacha" *(Datura meteloides)*. Numerous adults and some larvae were collected at Indio on November 15, on the same host plant. A tachinid fly, *Stomatolydella infernalis* Townsend, described from New Mexico, was bred from a larva from Indio, and determined by D. G. Hall of the U. S. National Museum.

MARCH 11, 1946

The 483rd meeting was held at the H.S.P.A. Experiment Station on Monday, March 11, at 2:00 p.m., with President Krauss in the chair.

Members present: Messrs. Alicata, Bianchi, Bonnet, Faxon, Fullaway, Holdaway, Jensen, Keck, Krauss, Lewis, Nishida, Pemberton, Rosa, Sakimura, Swezey, Tanada Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitors: Messrs. G. A. Casella, R. D. Eichmann, C. P. Hoyt, M. S. Johnson, E. E. Kenaga and P. W. Weber.

PAPER

On behalf of G. F. Augustson, Mr. Zimmerman presented a paper entitled: "Xenopsylla Fleas of the Hawaiian Islands (Siphonaptera: Pulicidae)."

NOTES AND EXHIBITIONS

Ophiomyia lantanae (Froggatt)—Mr. Krauss reported breeding this agromyzid fly from lantana berries collected in October and early November at Pasadena, Hollywood and Santa Barbara, Calif. This is the species established in Hawaii from Mexico by the late Albert Koebele in 1902.

Vanessa cardui (L.)—Dr. Swezey exhibited parasites from pupae of this butterfly. Three caterpillars from Oahu Sugar Co. yielded one tachinid (*Frontina archippivora* [Williston]) and one ichneumonid (*Pterocormus rufiventris* [Brullé]), a parasitism of 66 per cent.

Amyna natalis (Walker)—Dr. Swezey reported the discovery of the caterpillars of this new immigrant agrotid moth, previously known only from adults collected in light traps on Oahu. In sweeping *Sida cordifolia* among kiawe (*Prosopis*) trees in the Ewa-Waimanalo district along the Waianae road, several green larvae were obtained, from which adult *Amyna* were reared on March 11. From four of the larvae *Meteorus laphygmae* Viereck issued. Some days later *Amyna* caterpillars were also found on *Sida rhombifolia, Abutilon incanum* and *Waltheria americana,* at various points at Aiea, Waipio, Waipahu and Barber's Point.

Mexican beetles intercepted—Dr. Williams reported for Mr. Look that last August several twigs used in imported crates of pottery from Mexico, were found at Hilo heavily infested by coleopterous larvae. The material was destroyed, but two of the beetles obtained were sent to the U. S. National Museum for determination. A scolytid was identified by W. H. Anderson as (or near) *Renocis mexicanus* Blackman, and a bostrichid by W. S. Fisher as *Micrapate labialis* Lesne.

Hercothrips fasciatus (Pergande)—Mr. Bianchi reported that on February 20, Mr. Rosa and he found colonies of this bean thrips feeding on leaves of *Heliotropium curassavicum* at Barber's Point, Oahu. This is a new host and island record for the species. The

site of the find, like that on Molokai where Mr. Krauss found the species last year, is near an Army establishment, suggesting the probability that the infestation originated from specimens imported on oranges or other produce.

Hymenia recurvalis (Fabr.)—Mr. Bianchi spoke of the great abundance at Barber's Point of larvae of the Hawaiian beet webworm, or amaranth worm, on leaves and stems of *Sesuvium portulacastrum* and *Batis maritima*. Among the caterpillars were found a few cocoons of the introduced braconid, *Apanteles marginiventris* (Cresson).

Volucella sp.—Dr. Williams reported that an earlier record for this recent immigrant syrphid fly than his, reported last month, is supplied by a specimen taken by Charles Hoyt on January 1, 1946, in Honolulu.

Polydesma umbricola Boisduval—Mr. Fullaway reported finding the larva of this agrotid moth feeding on rose buds at Kahala, Honolulu. Mr. Pemberton reported that Mr. Van Zwaluwenburg and he had under observation the conspicuous damage being done currently by *Polydesma* larvae to monkey pod trees (*Samanea saman*). In many cases the unopened leaf buds are completely eaten out.

Eucelatoria armigera (Coquillett)—Mr. Rosa reported rearing this tachinid fly from the larva of *Hymenia recurvalis* (Fabr.), a new host record.

APRIL 8, 1946

The 484th meeting was held at the H.S.P.A. Experiment Station on Monday, April 8, at 2:00 p.m., with Vice-president Sakimura in the chair.

Members present: Messrs. Alicata, Bianchi, Faxon, Fullaway, Holdaway, Jensen, Lewis, Nishida, Pemberton, Rosa, Sakimura, Swezey, Tanada, Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitors: Messrs. C. P. Hoyt, L. K. Jones, K. L. Maehler, R. G. Oakley and H. K. Townes.

PAPER

On behalf of Dr. R. L. Usinger, Dr. Swezey presented a paper entitled: "Notes on Graptostethus in Hawaii (Hemiptera: Lygaeidae)."

NOTES AND EXHIBITIONS

Scatopse fuscipes Meigen—Mr. Wirth reported that Dr. Alan Stone of the U. S. National Museum determined as this species a scatopsid fly taken at lights in July, 1946, at Hickam Field and in Honolulu. It is widespread, and was formerly known as *Rhegmoclema atrata* Say. However, Duda considers *atrata* to be a synonym of *fuscipes,* and as *Rhegmoclema* is of doubtful validity, he sinks it under *Scatopse.* Bryan (Proc. Haw. Ent. Soc., **8**: 406, 1934) reported that "*Rhegmoclema atrata* was captured in a parasite cage from California in 1915. It is not known to be established."

Psychoda phalaenoides (L.)—Mr. Wirth reported that specimens swept from vegetation and on an overhanging ledge on the west slope of Mt. Tantalus, Oahu, in October 1945, were determined as this species by Dr. Wm. F. Rapp of the University of Illinois. This is a widespread species occurring in sewage sprinkler beds and other decaying organic matter throughout North America and Europe. It is not surprising that it has spread to Hawaii; its spread was probably effected by commerce as in the case of several other species of psychodids.

Haplothrips sesuvii Priesner—Mr. Bianchi reported finding this thrips in great numbers on *Sesuvium portulacastrum* near the beach at Barber's Point, Oahu, on March 12, 1946. This is a new record for the species in the Territory. It was described from the same plant host from Java (Rec. Indian Mus., **35**: 363, 1933).

Hercothrips fasciatus (Pergande)—Mr. Sakimura reported another isolated infestation by this bean thrips, April 7, on *Heliotropium curavassavicum* and *Sonchus oleraceus* on the leeward side of Kaena Point, Oahu. This habitat is an extremely dry, rocky coast with a limited number of low littoral plants. Many of the *Heliotropium* and *Sonchus* plants were heavily infested within a small area about 50 by 10 feet. Other plants present, but not found infested, were *Jacquemontia sandwicensis, Sida fallax, Atriplex semibaccata, Opuntia megacantha* and wild tomato. Only the one infestation was seen along the two-mile-long beach between Kaena light and Keawaula valley.

Anagrus yawi Fullaway—Mr. Fullaway reported that this egg parasite of the bean capsid, *Pycnoderes quadrimaculatus* Guérin, introduced from Mexico and established in 1943, was again recovered in Kaimuki, Honolulu.

Haematopinus suis (L.)—Dr. Alicata reported that DDT used at 2 and 5 per cent, either as dust or spray, was successful in controlling hog lice on pigs. The lice began dropping from the host animals about three hours after treatment.

MAY 13, 1946

The 485th meeting was held at the H.S.P.A. Experiment Station on Monday, May 13, at 2:00 p.m., with President Krauss in the chair.

Members present: Messrs. Alicata, Bianchi, Bonnet, Faxon, Fullaway, Holdaway, Jensen, Krauss, Lewis, McBride, Marlowe, Nishida, Pemberton, Rosa, Sakimura, Swezey, Tanada, Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitors: Miss Mabel Chong; Messrs. G. J. Carr, R. D. Eichmann, Gonzales Merino, C. L. Ritchie and J. S. Williamson.

Dr. C. L. Ritchie was nominated for membership in the Society.

NOTES AND EXHIBITIONS

Dacus dorsalis Hendel—Mr. Fullaway exhibited specimens of a trypetid fly new to the Territory, determined by Dr. Williams as this species. It was reared May 10, 1946 from mango fruits collected on Dole St., Honolulu, by Miss Mabel Chong.[1]

Pulvinaria psidii Maskell—Mr. Fullaway exhibited specimens of this coccid collected on leaves of *Anthurium.*

Isodontia harrisi Fernald—Dr. Swezey exhibited a specimen of this wasp, reared about May 6 from a cocoon in a burrow of the carpenter bee (*Xylocopa*). The burrow was found by George McEldowney in a dead branch of *Vitex* at Wahiawa, Oahu, March 22.

Tendipedid notes—Mr. Wirth presented the following: *Pentaneura* sp. This appears to be the first record of the subfamily Tanypodinae from the Hawaiian Islands. The first specimen, a female, was taken in July 1945 in a light trap at the Marine Corps Air Station dispensary, Ewa, Oahu. Two females were taken in January 1946 at the Kahuku Army air base. On March 25, about a pint of water and algae was taken from a nearly dry pond about 50 yards from the beach at the end of the Marine Air Station runway, and brought into the laboratory. The peculiar tanypodine larvae and pupae were noted, and during the six weeks the water was under observation, about 50 midges emerged. Both the Kahuku and Ewa areas are characterized by shallow, marshy, algae-choken ponds, rich in aquatic insect life.

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[1] Subsequently, among some 22,500 fruit flies collected or reared in Honolulu by O. C. McBride between April and July 1945, a single female specimen of *Dacus dorsalis* was found. This advances the earliest known date of its presence here by about one year. No *dorsalis* was found among an additional 50,000 flies collected by Mr. McBride between November 10, 1942 and April 1945. It is the belief of some of the local entomologists that the introduction of *dorsalis* into Hawaii was effected from Saipan; that it was probably brought by combat troops returning to rest camps here; and that possibly it arrived as early as the late summer of 1944. From observations by Dr. Jensen and others, relative to damaging infestations, and from complaints by gardeners and growers, it is suggested that *dorsalis* came first to the island of Hawaii, and a few months later to Oahu. [ED.].

Also of interest was the rearing of the "plain-legged" *Tendipes* sp. and the "spotted-winged" *Polypedilum* sp., from the same Ewa ponds. Adults of these tendipedine midges, as well as the heleid, *Dasyhelea hawaiiensis* Macfie, and two undetermined species of Orthocladiinae, were collected in numbers by sweeping grassy pond margins.

Anacamptodes fragilaria (Grossbeck)—Mr. Rosa reported finding this geometrid larva feeding on mint, a new host plant for the species. Mr. Krauss reported finding in California, two ichneumonid parasites of *Anacamptodes* larvae: *Campoplegidea flavescens* Walley, reared from larvae on willow at Riverside, and an undescribed species of *Phobocampe,* reared from a larva on *Acacia* at Pasadena. The parasites were determined by Dr. H. K. Townes.

Achatina fulica (Férussac)—Mr. Krauss reported observing the giant African snail in two areas on Guam last April. The snail is believed to have been introduced into Guam on sweet potato plants from Rota in 1943. An eradication program is under way. Other islands in the Marianas where the snail is established are Tinian and Saipan, where it is sometimes very destructive to crops; it also occurs on Ponape. Dr. Merino stated that this snail has recently been found near Manila, in the Philippines.

Johnston Island insects—Mr. Krauss reported that during a short stop-over on May 1 on Johnston Island, a coral islet some 800 miles southwest of Honolulu, he had collected the following insects: *Sympherobius barberi* Banks (Hemerobiidae); *Nysius terrestris* Usinger (Lygaeidae); *Frankliniella sulphurea* Schultz (Thysanoptera); the coccid parasite *Aenasius advena* Compere (Encyrtidae); and the flies *Desmometopa m-nigrum* Zetterstedt, *Ischiodon scutellaris* (Fabr.), *Musca domestica* L. and *Sarcophaga barbata* Thomson.

Mealybug parasites—Mr. Sakimura reported that the following hymenopterous parasites of *Pseudococcus comstocki* (Kuwana) were recently imported from the U. S. Bureau of Entomology laboratory at Charlottesville, Va.: *Pseudaphycus* sp. near *orientalis* Ferriére, *Allotropa convexifrons* Muesebeck, *Allotropa burrelli* Muesebeck and *Clausenia purpurea* Ishii. With the exception of *A. convexifrons,* all failed to oviposit in *Pseudococcus brevipes* (Cockerell); *convexifrons* failed to develop on the *brevipes* host.

New publication—Dr. Holdaway announced that the University of Hawaii is sponsoring a new quarterly periodical, *Pacific Science,* and will welcome original articles on the biological and physical sciences concerning the Pacific Ocean area. The publication will appear in January 1947; Dr. A. Grove Day of the University is the editor.

Insects infesting red squill—Dr. Holdaway reported that a dermestid, *Eucnocerus anthrenoides* Sharp (?), and a booklouse

tentatively identified as *Liposcelis divinatorius* (Muller), were found in Honolulu attacking red squill rat baits. Identification of the beetle was made by Dr. Swezey by comparison with material determined tentatively some years ago.

Tribolium confusum Jacq. du Val.—Dr. Holdaway exhibited a taro flour-skim milk product manufactured in Honolulu which was infested by *Tribolium confusum*. Infestation occurred in the factory.

Enallagma sp.—Dr. Williams presented the following: In the Puupukea forest, Oahu, April 11, both sexes of this immigrant damselfly were observed catching the tiny water-running veliid bug, *Microvelia vagans* White, from the surface of a pool, and then alighting on some convenient object to devour their prey. The damselflies would inspect the surface of the water, picking up flotsam here and there, and with a well-aimed pounce, seize a *Microvelia*.

Protoparce quinquemaculata blackburni (Butler)—Dr. Williams spoke of finding 11 eggs of this large sphinx moth on *Nicotiana glauca* near Mapulehu, Molokai on January 10. Eight proved to be parasitized by *Trichogramma*, one of the eggs producing 57 of the tiny wasps, mostly males. One sphinx larva was reared to maturity, requiring 56 days from hatching to adult.

JUNE 10, 1946

The 486th meeting was held at the H.S.P.A. Experiment Station on Monday, June 10 at 2:00 p.m., with Vice-president Sakimura in the chair.

Members present: Messrs, Alicata, Bianchi, Bonnet, Fullaway, Holdaway, Jensen, Keck, Lewis, McBride, Nishida, Pemberton, Ritchie, Rosa, Sakimura, Swezey, Van Zwaluwenburg, Weinrich, Williams and Wirth.

Visitors: Messrs. Samuel Beller, O. K. Courtney, J. A. Duggins, R. D. Eichmann, C. P. Hoyt, K. L. Maehler, M. M. Ross and O. O. Stout.

Dr. C. L. Ritchie was elected to membership in the Society, and Messrs. Samuel Beller, O. K. Courtney, J. A. Duggins, K. L. Maehler and O. O. Stout were nominated for membership.

NOTES AND EXHIBITIONS

Solindenia sp.—Mr. Fullaway exhibited a eupelmid wasp new to the Territory, captured by Mr. Rosa recently in the H.S.P.A. Experiment Station building. It is quite different from the species

of *Solindenia* previously known there, particularly in the shape of the head, which is shagreened and colored brassy green; the body is smooth and is yellow marked with black.

Chrysoplatycerus splendens (Howard)—Mr. Fullaway exhibited still another insect new to these islands, the above species, reared from *Pseudococcus citri* (Risso) and *P. maritimus* (Ehrhorn) collected on monkey pod (*Samanea saman*) foliage on Judd St., Honolulu, June 3, 1946. This encyrtid parasite was originally described from California in the genus *Rileya* (Entom. Americana, 4: 80, 1888; Canadian Ent., **20**: 194, 1888).

Dacus dorsalis Hendel—Mr. Fullaway reported that this newly introduced trypetid fly is now known on Oahu from Koko Head to Waianae, and on the windward side from Waimanalo to Kahaluu. It has been taken at Wahiawa, but has yet to be found in the Waialua-Mokuleia district. On the outer islands it is known from Hawaii and from a single specimen caught in a trap at Lahaina, Maui. For Mr. Look he reported that the fly is generally spread on Hawaii from Kona to Hilo, and from Kohala to Naalehu. *D. dorsalis* was especially numerous at Kohala, where 174 males were trapped in ten minutes, and at Kawaihae, where 115 were taken in the same length of time. Mr. Look bred it from fruits of waiawi (*Psidium* sp.) collected November 18, 1945, and later from mountain apple (*Eugenia malaccensis*), as well as from ripe bananas. On Oahu Mr. Fullaway has bred *D. dorsalis* from pomelo, and Mr. Van Zwaluwenburg reported rearing it from rose apple (*Eugenia jambos*).

Insects attacking *Cordia* fruits—Dr. Swezey reported rearing the following insects from fruits of *Cordia subcordata* collected at Barber's Point, Oahu, February 26 and March 6: *Pyroderces rileyi* (Walsingham); *Decadarchis* sp.; *Sybra alternans* Wied. and *Catorama sharpi* Pic[2]. There were ten of the last-named species, an insect hitherto raised abundantly from old pods of *Acacia farnesiana*. *Cordia subcordata* appears to be a new host for this anobiid. *C. sharpi* has been taken in light traps in the Pearl Harbor area in large numbers.

Gelis tenellus (Say)—Dr. Swezey reported rearing this ichneumonid from a cocoon of *Hyposoter exiguae* (Viereck) collected in the Hawaii National Park, May 23. He had previously bred it from cocoons of lacewing flies.

Copris and *Onthophagus*—Dr. Swezey exhibited specimens of *Copris incertus prociduus* Say and *Onthophagus incensus* Say, collected at Kapapala ranch, Kau, Hawaii, May 25. They were abundant in horse manure and cow droppings and had so thoroughly

[2] Pic (Bull. Soc. ent. France, 1912, p. 265) points out that the name *C. pusilla*, given by Sharp to the species in Hawaii, is preoccupied by that of a North American species described by LeConte in 1858. [Ed.].

worked this material that it was too dry for the hornfly maggots, none of which were present. It is apparent that these two beetles, introduced from Mexico in 1923 for this purpose, can be very effective, particularly in dry regions such as the Kau district.

Chrysobothris sp.—Mr. Hoyt exhibited a buprestid beetle belonging to this genus, which was taken alive on June 8, 1946 on a lawn near a mango tree on Thurston Ave., Honolulu. According to Dr. Williams, it is probably a Philippine species.

Tarsonemus latus Banks—Mr. Pemberton said that a hedge of the plant known locally as mock orange (*Murraya exotica*) had the tips of the branches stunted and the leaves distorted as a result of a heavy infestation by the broad mite.

Hawaiina perkinsi (Swezey)—Mr. Bianchi mentioned rearing a specimen of this rare native sphinx moth from a larva found feeding on a native *Euphorbia* on Mt. Kaala, April 17. In the laboratory the larva fed readily on the beach *Scaevola* (*S. lobelia*) as well as on the mountain species, *S. chamissoniana*. Feeding on the *Euphorbia* was extensive, but careful search failed to reveal more than the one specimen. This suggests that birds, numerous on Mt. Kaala, may prey heavily on the caterpillars.

JULY 8, 1946

The 487th meeting was held at the H.S.P.A. Experiment Station on Monday, July 8, at 2:00 p.m., with President Sakimura in the chair.

Members present: Messrs. Beller, Bianchi, Fullaway, Holdaway, Lewis, Maehler, McBride, Pemberton, Sakimura, Stout, Swezey, Tanada, Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitor: Mr. Leo Kartman.

It was announced that the Executive Committee had elected Kay Sakimura President, to complete the unexpired term of N. L. H. Krauss, temporarily absent from the Territory, and that Dr. D. D. Bonnet had been chosen Vice-president.

Messrs. Samuel Beller, O. K. Courtney, J. A. Duggins, K. L. Maehler and O. O. Stout were elected to membership in the Society. Mr. Marshall Ross was nominated for membership.

PAPER

Dr. Swezey presented a paper entitled: "Elaphria nucicolora (Guenée), a recent Immigrant to Hawaii (Lepidoptera: Agrotidae: Acronictinae)."

NOTES AND EXHIBITIONS

Dacus dorsalis Hendel—Mr. Fullaway reported for Mr. Look: The mango fly has been bred from peaches at Waimea, Hawaii, from oranges at Mountain View, and from pepino (*Solanum muricatum*) and rose apple at Hilo. Figs and loquats also appear to be stung by *D. dorsalis*. Adult males were observed on gardenia, on *Cattleya* blossoms and on carrot plants. Both sexes were collected from flowers of *Vanda Miss Joaquim*. Mr. Pemberton spoke of a recent letter from Dr. Alan Stone concerning the identity of this fly. Dr. Stone is of the opinion that *Dacus dorsalis* Hendel should be used, not *D. ferrugineus* (Fabr.) var. *dorsalis*. The species described by Fabricius in 1794 as *Musca ferruginea* becomes a primary homonym and invalid because preoccupied by *Musca ferruginea* Scopoli 1763. Thus, according to Dr. Stone, *dorsalis* is apparently the next available name. Mr. Beller stated that in Siam the following fruits are hosts of *Dacus ferrugineus: Psidium guajava, Eugenia* sp., *Diospyros packmanni*, eggplant, banana, mango, *Sandoricum indicum* and *Zizyphus jujuba*.

New eriophyids—The two new species of eriophyid mites reported by Mr. Look last year (Proc. Haw. Ent. Soc., **12**: 473, 488) have now been described by H. H. Keifer. The one on hibiscus (reported earlier as *Epitrimerus* sp.) is named *Tegonotus hibiscellus*, and the one on mango, *Oxypleurites mangiferae*. The descriptions appear in the Monthly Bulletin of the California State Board of Agriculture, **35**: 42, pl. 202; and *idem:* 43, pl. 203, 1946.

Melophagus ovinus (L.)—Mr. Pemberton exhibited 11 specimens of this hippoboscid collected from a wild sheep in June at Puu Laau on the west slope of Mauna Kea, Hawaii by L. W. Bryan, at an elevation of 8000 feet. Mr. Bryan stated that it is common on wild sheep in that locality. Previous records of this species are by Muir (Proc. Haw. Ent. Soc., **7**: 4, 1928) who took a single specimen from a bag of forest seeds adjacent to a sheep run at Honohina, Hawaii in December 1926, and by Swezey and Williams (Proc. Haw. Ent. Soc., **8**: 188, 1932) who found one specimen in the saddle room at Keanakolu, Hawaii in October 1931 at an elevation of 5250 feet.

Trissolcus murgantiae Ashmead—Mr. Fullaway exhibited specimens of this scelionid described (U. S. Nat. Mus. Bull., **45**: 163, 1893) as a parasite of *Murgantia histrionica* (Hahn). This was recently introduced from California and is being propagated by the Board of Agriculture and Forestry. It is said to be a more effective parasite of the harlequin cabbage bug than *Ooencyrtus johnsoni* (Howard)[3], previously introduced and established here.

[3] This encyrtid enemy of *Murgantia* eggs was introduced from California in 1940 by the Board of Agriculture and Forestry, but has until now escaped notice in these Proceedings despite the fact that it is now well established here. It was described in 1898 from Maryland as *Encyrtus johnsoni* (Canadian Ent., **30**: 18).

It completes its development in the egg in 11 days.

New insect records—For Mr. Davis, Dr. Swezey reported the following insects new to the Territory; the aphids were determined by Prof. E. O. Essig, and the drosophilid by Dr. Gordon Mainland:

Rhopalosiphum prunifoliae (Fitch); on leaves and stems of *Cynodon dactylon;* Kilauea ranger station, Hawaii, 3900 ft., May 17, 1945, C. J. Davis, coll.

Macrosiphum granarium (Kirby); on seed heads of *Deschampsia hawaiiensis;* crater floor, Haleakala, Maui, 7000 ft., Sept. 3, 1945, A. L. Mitchell, coll.

Drosophila busckii Coquillett; in trap, nursery, Kilauea, Hawaii, 4000 feet, Nov. 25, 1945, C. J. Davis, coll.

Polydesma umbricola Boisduval—Dr. Williams reported that he had been told of typical *Polydesma* damage observed on monkey pod trees at Kukuihaele and Kona, Hawaii. Mr. Fullaway said that Mr. Look had found *Polydesma* larvae on monkey pod at Kona and at Hilo last June.

AUGUST 12, 1946

The 488th meeting was held at the H.S.P.A. Experiment Station on Monday, August 12, at 2:00 p.m., with President Sakimura in the chair.

Members present: Messrs. Beller, Bonnet, Courtney, Fullaway, Holdaway, Jensen, Keck, Lewis, McBride, Nishida, Pemberton, Ritchie, Rosa, Sakimura, Williams, Wirth and Zimmerman.

Visitors: Messrs. A. C. Baker, J. W. Balock, Leo Kartman, C. E. Norlund and R. S. Schenk.

Mr. Marshall Ross was elected to membership in the Society.

PAPER

Dr. Swezey presented a paper entitled: "Neoclytarlus on Chenopodium on the Island of Hawaii (Coleoptera: Cerambycidae)."

NOTES AND EXHIBITIONS

Hercothrips fasciatus (Pergande)—Mr. Sakimura reported for Mr. Look that large numbers of the bean thrips were collected from prickly poppy (*Argemone alba glauca*) at Puu Waawaa, Kona, Hawaii, September 18. As many as five adults and 50 nymphs were observed on a single leaf. Nearby plants of *Sonchus oleraceus* were examined, but no thrips were found on them. Under dry conditions a light infestation by this species was found on

S. oleraceus on the saddle road between Mauna Kea and Mauna Loa, Hawaii, at 6500 feet, July 2.

Rhinoncus pyrrhopus Boheman—Mr. Zimmerman exhibited specimens of this ceutorhynchine weevil, new to the Territory. It was swept by him from grass and low herbage at the sheep station, Huumula, Hawaii, August 3 and 7, 1946. It is widespread in Europe and North America, and is reported by Blatchley to feed on *Rumex, Polygonum* and *Euphorbia.*

Dacus dorsalis Hendel—Mr. Fullaway reported that Mr. Look had reared this new trypetid from avocado, loquat and fig at Hilo, Hawaii. *D. cucurbitae* Coquillett also issued from the figs. Mr. Pemberton added that *dorsalis* has been found to lay its eggs in cracks, stem holes and injuries in avocados.

Gnorimoschema operculella (Zeller)—Mr. Look reported breeding the potato tuber moth from *Physalis peruvianum* found at 6500 feet on the Mauna Loa-Mauna Kea saddle road.

Triatoma rubrofasciata (Degeer)—Dr. Bonnet exhibited a jar containing 18 specimens of this cone-nose in various stages. They were reared from eggs from a single female obtained from Mr. Bianchi October 16, 1945. The female laid 12 eggs on October 17. Fertile egg production continued until February. The eggs hatched in about 28 days at room temperature (76° F.). The eggs are a creamy white when laid, later changing to yellow, to orange, and finally to pink just before hatching.

The first instar did not take a blood meal before from four to six days after hatching. The time required for repletion was from eight to 15 minutes. The bite of the early instars was usually painless, with a delayed itching sensation; only a slight red mark is left unless the area is scratched. The female usually, but not always, defecates immediately prior to conclusion of the blood meal. Cannibalism was observed on two occasions. The bite of the later instars is increasingly severe, and when several bugs are biting at once the pain and tickling becomes almost unbearable. No untoward effects were noted at any time as a result of the bites. There are five nymphal instars, and the total time for development to adult in this instance was 277 days. This will vary with frequency of blood meals, for the insect does not moult unless fed to repletion.

Moth larva at high altitude—Dr. Swezey reported that Mr. Davis had found a nearly mature larva of an unidentified agrotid within a cave on Mauna Kea at an elevation of about 12,000 feet. The surroundings were exceedingly barren, and no sign of any food plant could be discovered.

However, enough suitable vegetation must have been present to bring the larva through its earlier instars, and it may have wandered into the cave in search of further food or for a place in which to pupate. The larva was not reared to adult. Dr. Swezey reported

having once found three adults of *Euxoa mesotoxa* (Meyrick) in a nearly empty soda water bottle at Lake Waiau, 13,000 feet, Mauna Kea. Possibly a moth of this, or some other native species, the larvae of which are unknown, took shelter in the cave and found some vegetation in the vicinity for oviposition.

Ethmia colonella Walsingham—Dr. Swezey reported that Mr. Davis in March found larvae of this moth defoliating kou (*Cordia subcordata*) on the Kona coast of Hawaii between Kailua and Keauhou. This is the first record of this insect from the island of Hawaii.

Kalotermes immigrans Snyder—Mr. Fullaway exhibited live wood of *Leucaena glauca* from Ulupalakua ranch, Maui, in which this native termite was feeding.

A new centipede—Mr. Pemberton exhibited a centipede new to the Territory, taken in July 1946 in Nuuanu valley. According to Dr. Williams it appears to be a species of *Otostigmus*[4].

SEPTEMBER 9, 1946

The 489th meeting was held at the H.S.P.A. Experiment Station on Monday, September 9, at 2:00 p.m., with President Sakimura in the chair.

Members present: Messrs. Alicata, Beller, Bianchi, Bonnet, Fullaway, Hadden, Holdaway, Keck, McBride, Nishida, Pemberton, Rosa, Sakimura, Swezey, Tanada, Van Zwaluwenburg, Williams and Zimmerman.

Visitors: Messrs. J. W. Balock, G. S. Mansfield, R. G. Oakley and H. K. Townes.

PAPERS

For Mr. Wirth, Dr. Williams presented two papers: "Notes on Thalassomyia Schiner, with Descriptions of two new Species (Diptera: Tendipedidae)," and "Ephydra gracilis Packard, a recent Immigrant Fly in Hawaii (Diptera: Ephydridae)."

NOTES AND EXHIBITIONS

Murgantia histrionica (Hahn)—Dr. Holdaway called attention to increasing numbers of reports of infestations by this bug in various parts of Honolulu, particularly in the vicinity of the University and at Kalihi. Hosts attacked have been nasturtium, head cabbage, Chinese cabbage, "tender green" (a green mustard), broccoli, Brussels sprouts and kale mustard cabbage.

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[4] Subsequently determined by Dr. R. V. Chamberlin as *Otostigmus scaber* Porat, described from China (Sv. Ak. Handl., 4 [7]: 20, 1874 [1876]).

Araecerus fasciculatus (Degeer)—Mr. Bianchi exhibited five adults of this anthribid beetle reared from flower buds of gardenia at Kukuihaele, Hawaii in August. The larvae had bored tunnels through the basal portions of the unopened buds, feeding and eventually pupating there, and in most cases completely ruining the flowers. This is a hitherto unreported habit for this species, which usually develops in dead, dry vegetable matter. It was reported that practically no perfect blossoms were obtained this year from the 15 or 20 bushes on which the beetles were found.

Achaea janata (L.)—Mr. Bianchi reported that on a recent visit to Hawaii in early August he had seen evidence that populations of this agrotid have not greatly diminished on that island. This is in contrast to conditions on Oahu. At Pahala, Hawaii, where great numbers of larvae were found in June 1945, heavy defoliation of castor bean has continued intermittently throughout the present year, and is now still apparent, although the caterpillars themselves have disappeared.

Eurytoma on *Latrodectus*—Mr. Bianchi reported that he had reared this parasite from egg cases of *Latrodectus mactans* (Fabr.) and *L. geometricus* Koch, collected at South Point, Hawaii in August. *Eurytoma* was liberated in this locality in June 1945, and this is the first record of its recovery on that island. Four out of nine egg cases of *mactans* were parasitized, while out of 19 *geometricus* cases only two were attacked. However, this difference is not reflected in the relative incidence of the two spiders, both of which are very scarce compared with their abundance in former years, although not scarcer than they are in general on Oahu. Conversely, the food of the spiders (several species of cockroaches and tenebrionids) is strikingly more abundant than it has been since 1939 when Mr. Bianchi first visited the region.

Dacus dorsalis Hendel—Mr. Keck reported rearing this new trypetid from fruits of the canistel (*Lucuma nervosa*).

Mealybug parasites—Mr. Sakimura reported that a small shipment of *Tetracnemus peregrinus* Compere and three unidentified encyrtids, all parasitic on mealybugs, was received in August from Dr. Carter from Rio de Janeiro. None of them was observed to oviposit in *Pseudococcus brevipes* (Cockerell). A shipment of *Leptomastix dactylopii* Howard was also received recently from Dr. S. E. Flanders from Riverside, Calif. Oviposition by this species in *P. brevipes*, though infrequent, was observed, and further trials with *Leptomastix* will be made when further material arrives.

Barypolynema saga (Girault)—Dr. Swezey called attention to a change in the generic name of this mymarid parasite of the eggs of the cicadellid, *Euscelis stactogallus* (Amyot). It is recorded locally (Proc. Haw. Ent. Soc., **7**: 224, 340, 1931) as *Polynema*

saga (Girault). Recently Oglobin has transferred it to the new genus *Barypolynema* (Iowa State Coll. Jl. Science, **20** [3] : 282-285, 1946).

Perkinsiella saccharicida Kirkaldy—Dr. Swezey exhibited a small white cocoon on a bit of leafsheath of sugarcane, collected at Ewa Plantation. The cocoon had a tiny hole where a parasite had issued. He explained that this particular cocoon, with the parasite exit hole, was positive evidence that three species of insects had been present: the sugarcane leafhopper, a dryinid parasite (*Pseudogonatopus hospes* Perkins) of the leafhopper, and a parasite of the dryinid, *Helegonatopus pseudophanes* Perkins, which had made the exit hole in the dryinid cocoon. None of the three insects was observed in the field, indicating their relative scarcity.

Typhlops braminus (Russel)—Mr. Van Zwaluwenburg exhibited a specimen of this burrowing snake captured September 2 on Seaside Ave., in the Waikiki district of Honolulu, while moving over the surface of the ground. This marks a considerable extension of the local range of this snake, which hitherto has been found most often in the Kalihi district, and a few times on Pacific Heights and in Makiki.

Olfersia aenescens Thomson—Mr. Pemberton exhibited for Mr. Maehler, 28 specimens of this hippoboscid fly collected on rocks on Rabbit Island, windward Oahu, August 28, 1946. Apparently the species has not been collected before on Rabbit Island, and there are no records of its occurence on nearby Oahu. On August 30 Mr. Maehler returned to the island and collected the fly from young shearwaters and noddy terns. According to Bequaert (Occ. Papers B. P. Bishop Mus., **16** [11] : 277-279, 1941), *aenescens* is widely distributed over tropical seas and occurs on many different marine birds. Previous records from the Hawaiian archipelago include only Laysan and Lisiansky.

Blattella lituricollis (Walker)—Mr. Zimmerman reported that Dr. A. B. Gurney of the U. S. National Museum had recently determined as this species the field cockroach which until now has been confused with *B. germanica* (Linn.), which also occurs here. Mr. Zimmerman's suspicions of the accepted identification were based on the field habits of this cockroach, which differ markedly from the well-established domesticity of *germanica*.

Iwo Jima insects—Mr. Van Zwaluwenburg presented the following list of insects collected on Iwo Jima by Robert E. Bertram during his stay on the island in late 1945 and early 1946. The Lepidoptera were identified by Dr. Swezey, and the other orders by Dr. Williams:

Orthoptera

Blattidae: undetermined cockroach nymph.
Mantidae: *Tenodera sinensis* Saussure.

Tettigoniidae: ? *Euconocephalus insulanus* (Redtenbacher).
Acridiidae: *Locusta migratoria danica* (L.).

Homoptera

Aphididae: *Aphis* prob. *gossypii* Glover.

Heteroptera

Miridae: ? *Creontiades stramineus* (Walker).
Pentatomidae: *Nezara viridula* (L.).

Neuroptera

Hemerobiidae: ? *Eumicromus* sp.

Lepidoptera

Pyralididae: *Hymenia recurvalis* (Fabr.).
Plusiidae: *Plusia chalcites* (Esper).
Agrotidae (Noctuidae):

Achaea janata (L.).
Amyna octo (Guenée).
Cirphis loreyi (Dup.).
Heliothis armigera (Hübner).
Mocis undata (Fabr.).
Prodenia litura (Fabr.).

Lycaenidae: *Cosmolyce boetica* (L.).
Various: one or more species of microlepidoptera too badly rubbed to identify.

Coleoptera

Nitidulidae: *Carpophilus humeralis* (Fabr.).
Coccinellidae:

Nephus sp.
Coccinella septempunctata bruckii Mulsant.

Scarabaeidae:

Anomala orientalis (Waterhouse) (This species was taken earlier on Iwo Jima by Major J. E. Webb, AUS.).

Diptera

Muscidae: *Musca* prob. *domestica* L.

Miscellaneous

Parasitic worms occurred about the roots of tomato; these were not submitted for identification, but undoubtedly were nematodes.
Mites affected the foliage of tomato plants, but were not identified.

OCTOBER 14, 1946

The 490th meeting was held at the H.S.P.A. Experiment Station on Monday, October 14, at 2:00 p.m., with President Sakimura in the chair.

Members present: Messrs. Alicata, Beller, Bianchi, Bonnet, Fullaway, Holdaway, Lewis, Maehler, Nishida, Pemberton, Ritchie, Rosa, Sakimura, Swezey, Tanada, Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitors: Messrs. Leo Kartman and P. W. Weber.

PAPERS

Mr. Wirth presented a paper entitled: "A Review of the Genus Telmatogeton Schiner, with Descriptions of three new Hawaiian Species (Diptera: Tendipedidae)." Mr. Bianchi presented a paper entitled: "Thysanoptera Hawaiiensis-I."

NOTES AND EXHIBITIONS

New aphid records—Dr. Swezey presented, for Mr. Davis, the following notes on some aphids new to the Territory, collected in Hawaii National Park, island of Hawaii, and identified by Prof. E. O. Essig:

Amphorophora vaccinii Mason; on terminal shoots of *Vaccinium reticulatum;* end of Mauna Loa truck trail, 6500 ft., May 22, 1946, C. J. Davis, coll.

Pterochlorus saligna (Gmelin); on terminal twigs of *Osteomeles anthyllidifolia;* old Peter Lee road, 5 m. west of Volcano House, 3500 ft., May 26, 1946, C. J. Davis and O. H. Swezey, colls. [Subsequently it was discovered that this species was taken by Giffard, 4000 ft., Kilauea, Hawaii, Aug., 1911; and by Giffard and Muir, Kahuku, Kau, Hawaii, Jan. 15, 1917.]

Phorodon menthae (Buckton); on ventral surface of leaves of *Mentha* sp.; Paio (prison camp), 3900 ft., June 6, 1946, C. J. Davis, coll.

Dacus dorsalis Hendel—Dr. Swezey reported rearing this new immigrant fly from breadfruit. A large proportion of the fruits on his tree in Manoa were heavily infested. The maggots seemed to congregate in the center of the fruit around the core, so that the infestation was not always detected by external softness of the fruit.

Mr. Fullaway reported that Mr. Look on Hawaii, had bred *D. dorsalis* from the following: coffee berries, plum (*Prunus*) (from Kilauea, a new locality), passion fruit (*Passiflora*) and *Terminalia catappa.*

Mr. Pemberton told of trapping male *D. dorsalis* in a coffee jar of water containing a few drops of citronella oil. In his garden on upper Keeaumoku St., in 59 consecutive days of trapping, 33,105 male *dorsalis* were caught. The trap was placed under an avocado tree which at the time bore no fruit; no fruits of any kind were seen in the vicinity.

Notes on Kauai Diptera—Mr. Wirth reported on some observations made during a recent trip to Kauai:

Clunio sp. At Wailua Falls, about four or five miles from the sea, about a dozen males with the wingless females attached, were captured while flitting just above the water's edge at the rapids immediately below the falls. This genus has never before been

taken except between tide marks on the seashore; it is problematical whether these individuals migrated this distance up the swift stream, or whether they are breeding in fresh water. As most of the males were in copulation with females, the latter is suggested.

Thalassomyia setosipennis Wirth[5]. This species, known previously only from Hilo, was found in numbrs at Nawiliwili bay and at Kilauea bay. Immature stages were taken in rock pools between tide marks at Nawiliwili. This indicates that the species prefers habitats where the sea water is freshened by stream effluents, promoting growths of the algae, *Ulva* and *Enteromorpha*.

Corynoneura sp. One specimen of this orthocladine tendipedid was taken on rank growth of nasturtium in a boggy area at Kokee. It is of minute size, the wing venation quite characteristic, with a "stigma" on the costal margin.

Lonchoptera sp. These small flies of the family Lonchopteridae, with characteristcally pointed wings, were abundant on nasturtium in a boggy area at Kokee.

Scatella sp. This ephydrid differs from other Hawaiian *Scatella* in having the wings rather light, with a prominent, infuscate, preapical patch. Most of the other species have dark wings with light spots. This is by far the dominant species of *Scatella* at all streams in the Kokee region. An earlier specimen was collected at Kokee by Dr. Williams in 1931.

Diptera new to Hawaii—Mr. Wirth reported that the following identifications of flies, none of them previously known in Hawaii, were received from the U. S. National Museum; the first four were determined by C. T. Greene, the last three by C. W. Sabrosky:

Tethina albula (Loew) (Opomyzidae). First taken in January 1946 at Waianae, Oahu; later at Waimanalo, Lanikai and Kailua, all on Oahu.

Mumetopia sp. (Opomyzidae) (previously determined only to family). First taken at light trap in August 1945 at Kunia, Oahu. Later taken also at Honolulu and Ewa, Oahu, and at Hilo, Hawaii.

Napomyza sp. (Agromyzidae). Taken on window near beach, Kailua, Oahu, June 1, 1946.

Calycomyza artemisiae (Kaltenbach) (Agromyzidae). First taken on Mt. Tantalus and at light trap, Hickam Field, Oahu, July 1945. Later, at light trap, Lanikai, Oahu.

Conioscinella sp. (Chloropidae).

Hecamede femoralis Malloch (Ephydridae). First taken at Waianae beach, Oahu, January 1946; later at Waimanalo, Oahu.

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[5] This species is described on p. 121 of this issue of the Proceedings.

Chaetoscatella sp. (Ephydridae) (probably endemic).

Some name changes among Diptera—Mr. Wirth reported the following identifications made by C. W. Sabrosky, of flies submitted from Hawaii:

Cadrema pallida (Loew) (Chloropidae) (previously in *Prohippelates*).

Rhodesiella scutellata (Meigen) (Chloropidae) (? *R. tarsalis* Adams).

Copromyza equina (Fallen) (Borboridae) (previously in *Borborus*).

Eumenes pyriformis (Fabr.) *petiolaris* (Schulz)[6]—This large vespid, first found in September at Makalapa, Oahu by Dr. Townes, seems to be extending its range on this island. Mr. Maehler reported capturing one recently at Hickam Field. Mr. Bianchi observed a jug-shaped nest of what may be this species in the forest reserve of Poamoho, above Wahiawa, on September 21; Mr. Weber saw an adult at Punaluu on October 7.

Liris aurata (Fabr.)—Mr. Weber exhibited a specimen of this oriental larrid wasp which he captured at John Rodgers airport, Oahu, on September 9, 1946; on the same day he saw another specimen at Ft. Kamehameha. This is the first record of this species in Hawaii. Identification was made by Dr. Williams. This wasp preys on *Gryllus* and *Gryllodes* crickets. It is known from China, Japan, Formosa, the Philippines, India and Africa. Recently Dr. Townes reported that it is common about airports in the southwest Pacific.

Tarsostenus and *Tillus*—Mr. Weber reported rearing the clerid beetles, *Tarsostenus univittatus* (Rossi) and *Tillus notatus* Klug, from *Leucaena glauca* wood infested by various bostrichids and lyctids. The Cleridae are generally predaceous in both larval and adult stages. *T. univitattus* is reported by Clausen to prey upon the genus *Lyctus* (*"Entomophagous Insects,"* p. 547, 1940).

Sierola sp.—Mr. Sakimura reported rearing a bethylid belonging to this genus from a pupa found within the eye of a pineapple fruit from Molokai. The host is believed to have been *Pyroderces rileyi* (Walsingham).

Mealybug parasites—Mr. Sakimura reported that three shipments of parasites of *Pseudococcus brevipes* (Cockerell), collected at Rio de Janeiro and Campinas, Brazil, have been received from Dr. Carter. Good numbers of *Anagyrus* sp. and ? *Pseudaphycus* sp. have emerged and are now being propagated on Hawaiian *brevipes*. The *Anagyrus* introduced from Brazil about ten years ago, and known here as *A. coccidivorus* Dozier, has been found to be neither this species nor *A. pseudococci* Girault; its identity

[6] See p. 105.

is still not known. *Leptomastix dactylopii* Howard, received from the Riverside, California laboratory, failed to oviposit on the local *P. brevipes.*

"Tidal" wave note—Mr. Look reported that at Keaukaha, Hawaii, an unidentified scolytid (*Xyleborus* sp.) was breeding in great numbers in mango trees dead or dying as a result of salt water damage caused by the tsunami of April 1. The beetles were observed to be very numerous in houses, along with the oedemerid beetle, *Ananca bicolor* (Fairmaire).

Lema enemies in California—Mr. Van Zwaluwenburg reported for Mr. Krauss on some enemies observed on *Lema californica* Schaeffer at Riverside, Calif. in June and July. This species, identified by H. S. Barber of the U. S. National Museum, is the insect formerly known in Hawaii as *L. nigrovittata* Guerin and *L. trilineata californica* Schaeffer. Mr. Krauss reared several *Spilochalcis delumbis* (Cresson) from its larvae. Adult dasytid beetles (*Dasytastes* sp.) and coccinellids (*Hippodamia 6-signata ambigua* LeConte) were seen feeding on *Lema* eggs, and four *Chrysopa* sp. (*plorabunda* group) were reared from larvae feeding on *Lema* eggs.

Uropoda sp.—Uropid mites, found by Mr. Krauss abundant on live dung beetles (*Copris incertus prociduus* Say) in March 1946 in Manoa, Honolulu, have been identified by Dr. E. W. Baker as probably belonging to this genus.

Parasite of black widow spider—Mr. Pemberton reported that from a number of egg sacs of *Latrodectus mactans* (Fabr.) collected by Dr. Williams at Kanoa, Molokai, on September 17, 1946, many of the recently known parasite, *Eurytoma* sp., had been reared. The parasite was released at Kanoa, the previous year, on September 6. It is now well established on all of the main Hawaiian islands and is apparently accountable for a definite decrease in the abundance of the spider.

NOVEMBER 18, 1946

The 491st meeting was held at the H.S.P.A. Experiment Station on Monday, November 18, at 2:00 p.m., with President Sakimura in the chair.

Members present: Messrs. Beller, Bonnet, Holdaway, Lewis, McBride, Maehler, Nishida, Pemberton, Ritchie, Rosa, Sakimura, Swezey, Tanada, Van Zwaluwenburg, Williams, Wirth and Zimmerman.

Visitors: Messrs. J. W. Balock and P. W. Weber.

Mr. Leo Kartman was elected to membership in the Society.

Messrs. J. W. Balock and P. W. Weber were nominated for membership and Mr. M. Matsuura, of Maui, was nominated for corresponding membership.

PAPERS

Dr. Bonnet presented a paper entitled: "The Distribution of Mosquito Breeding by Type of Container in Honolulu, T. H." Mr. Van Zwaluwenburg presented a paper: "Some Elaterid Beetles from Australia and New Guinea."

NOTES AND EXHIBITIONS

Dacus dorsalis Hendel—Mr. Van Zwaluwenburg reported that, following an earlier observation by E. L. Caum, Dr. Williams, Mr. Caum and he found numerous adult mango flies attracted to the foliage of a small bay tree (*Eugenia acris*) in the Manoa arboretum on October 24. At first no flies were present, but as soon as the sun came from behind a cloud, well over 100 flies settled on the foliage within a few minutes. Only male *D. dorsalis* were seen.

He further reported finding *D. dorsalis* on Molokai, a new island record. On November 13 ten male *dorsalis* were caught within two hours in a citronella oil trap in the mango planting at Mapulehu; by 10 the next morning a total of 185, all males, had been caught. A similar trap at Kawela yielded about 50 flies after 20 hours exposure, and one at Kaunakakai, approximately 200 after 22 hours; all were males. Traps set out last July by Mr. Pemberton in the mango planting at Mapulehu failed to attract any *D. dorsalis* at that time.

Mr. McBride presented the following list of field-collected host fruits of *D. dorsalis,* determined by the staff of the Honolulu laboratory of the Bureau of Entomology and Plant Quarantine and Foreign Plant Quarantines:

Avocado	*Persea americana*
Banana	*Musa sapientum*
Cactus	*Opuntia megacantha*
Chebula	*Terminalia chebula*
Dates	(Arabian seedling)
Fig	*Ficus carica*
Guava (common)	*Psidium guajava*
Guava (strawberry)	*Psidium littorale*
Kamani	*Terminalia catappa*
Lime	*Citrus aurantifolia*
Orange (sweet)	*Citrus sinensis*
Sour orange	*Citrus aurantium*
Mango	*Mangifera indica*
Mountain apple	*Jambos (Eugenia) malaccensis*

Rose apple	*Eugenia jambos*
Papaya	*Carica papaya*
Passion fruit	*Passiflora edulis flavicarpa*
Passion fruit	*Passiflora foetida*
Natal plum	*Carissa grandiflora*
Pomegranate	*Punica granatum*
Soursop	*Anona muricata*
Surinam cherry	*Eugenia uniflora*
Tomato	*Lycopersicon esculentum*
Ylang ylang	*Cananga odorata*
Canistel	*Lucuma nervosa*
Breadfruit	*Artocarpus communis*
Mabolo	*Diospyros discolor*
Coffee	*Coffea arabica*
Litchi	*Litchi chinensis*
Wi apple	*Spondias dulcis*
Sea grape	*Coccoloba uvifera*

To complete the host list to date, the following field-collected host fruits of *D. dorsalis*, previously reported at earlier meetings of the Society, are added:

Waiawi	*Psidium* sp.
Pomelo	*Citrus grandis*
Peach	*Prunus vulgaris*
Pepino	*Solanum muricatum*
Loquat	*Eriobotrya japonica*
Plum	*Prunus* sp.

Genophantis leahi Swezey—Mr. Van Zwaluwenburg reported that in October Mr. Rosa and he found very heavy infestations of this native phycitid moth on *Euphorbia bifida*, a new host plant, on the Ewa coral plain. Previously only *Euphorbia cordata* and *E. pilulifera* had been known as hosts. From the larvae the following parasites, identified by Dr. Swezey, were reared: the braconid, *Chelonus blackburni* Cameron, and the two ichneumonids, *Cremastus flavo-orbitalis* (Cameron) and *Pristomerus hawaiiensis* Perkins.

An eriophyid new to Hawaii—Mr. Nishida reported a mite on mango, previously unrecorded here, collected in Manoa, Honolulu. It has been identified by H. H. Keifer as *Aceria mangiferae* (Hassan), a species reported to cause damage to mango buds in Egypt. It is found between the layers of leaf scales at the growing point; a heavy infestation causes blackening of the leaf scales, and at times prevents development of normal new growth. Mr. Keifer writes that it is not to be confused with the eriophyid found by Mr. Look on mango (*Oxypleurites mangiferae* Keifer; see p. 13). The two are very different in habit; *Aceria* is a bud mite and is restricted to the enclosed spaces between the leaf scales, while *Oxy-*

pleurites is found on the exposed surfaces of the young stems and leaves, according to a personal communication from Mr. Look.

Recent determinations of Diptera—Mr. Wirth presented the following recent determinations of flies, the first two by C. T. Greene, and the third by C. W. Sabrosky:

Omphralidae (=*Scenopinidae*)
- *Omphrale lucidus* (Becker) (= *Scenopinus lucidus* [Kröber] Bryan, 1934)

Agromyzidae
- *Agromyza* sp., near *immaculata* Coquillett. Mt. Kaala, Oahu, July 25, 1946, W. W. Wirth (swept in bog at summit).

Ephydridae
- *Psilopa* sp., near *girschneri* von Röder. Ewa, Oahu, June 28, 1946, W. W. Wirth; Lanikai, Oahu, June 26, 1946, W. W. Wirth (swept in marshy areas near beach). Two black spots on veins at apex of the wings.

Tendipes (*Chironomus*) sp.—Mr. Wirth exhibited a female specimen of this fly, apparently the same as that reported by Dr. Williams (Proc. Haw. Ent. Soc., **12**: 158, 1944) from high elevations on Molokai, which he found among light trap collections made by C. J. Davis at Hawaii National Park, Kilauea, Hawaii, in November. The color is dark brownish gray throughout, including the wings. The mesonotum is narrower and more highly arched than in *T. hawaiiensis* (Grimshaw).

Pseudaphycus sp.—Mr. Sakimura reported that a new species of *Pseudaphycus* sent by Dr. Carter from Brazil, had been successfully bred on local *Pseudococcus brevipes* (Cockerell). Field liberations have just begun.

Heliothis armigera (Hübner)—Dr. Holdaway exhibited a photograph of a corn earworm larva found by Dr. R. C. Lindner within a small, immature papaya fruit. When the fruit was cut open the well-developed larva was found within, but there was no evidence of any hole whereby the insect had entered. Discussion led to the suggestion that at an earlier stage of the fruit's growth the young caterpillar might have entered the fruit between the stigmas at the blossom end.

Otostigmus scaber Porat—Dr. Holdaway exhibited living and preserved specimens of this centipede, first reported here in August (see p. 16). The specimens were collected at Kalihi-uka, Honolulu, at a location with comparatively high rainfall and luxuriant vegetation. Living specimens exhibit a blue banding of the caudal appendages which is lost in preserved material. According to Leonard Bishop he had seen this species in abundance some ten years ago at Punchbowl and in Manoa, as well as in Nuuanu and Kalihi. The

specimens collected by Dr. Holdaway were present in large numbers, and were associated with *Scolopendra subspinipes* Leach and with a short brown species.

Coptotermes formosanus Shiraki—Dr. Holdaway exhibited a queen of this termite taken from timber of the elevator-housing, three floors above the street, in a downtown Honolulu office building.

Caryoborus gonagra (Fabr.)—Dr. Holdaway exhibited a pine bureau drawer which showed shallow borings made by larvae of this bruchid. Some of the borings contained the beetles' cocoons. Adults were present, and on the outside, at the back of the drawer, eggs were present. The drawer had contained cardboard and sheets of paper, the former exhibiting shallow beetle borings.

A *Eumenes* new to Hawaii—Mr. Maehler exhibited specimens of a *Eumenes* new to the Territory, collected October 16, 1946 at Hickam Field nursery, Oahu. It was identified by K. V. Krombein as *E. campaniformis* (Fabr.), from the Malayan and Australian regions. Dr. Bequaert (Ann. Mus. So. Africa, 23[3]:541, 1926) records *campaniformis* from Java, the Philippines, Queensland and Yule Is., New Guinea. There are several varieties of *campaniformis*.

Oxytheira sp.—Mr. Sakimura reported that during October he had collected specimens of this small, moth-like trichopteron swarming over grass near a reservoir at Kunia, Oahu. Dr. Swezey remarked that the same insect was occasionally taken in light traps operated by the Navy last year in the Pearl Harbor area.

DECEMBER 9, 1946

The 492nd meeting was held at the H.S.P.A. Experiment Station on Monday, December 9, at 2 p.m., with President Sakimura in the chair.

Members present: Miss Amy Suehiro; Messrs. Balock, Beller, Bonnet, Bryan, Fullaway, Holdaway, Ito, Lewis, Maehler, McBride, Pemberton, Rosa, Ross, Nishida, Ritchie, Sakimura, Schmidt, Stout, Swezey, Tanada, Van Zwaluwenburg, Weber, Williams and Zimmerman.

Visitors: Messrs. Edmond Dennery and Ray Greenfield.

J. W. Balock, M. Matsuura and P. W. Weber were elected to membership in the Society, and Edmond Dennery was nominated for membership.

This being the annual meeting, the following slate of officers to serve during the coming year was presented:

President .... David D. Bonnet
Vice-President .... D. T. Fullaway
Secretary-Treasurer .... F. X. Williams
Additional members
of Executive Committee .... C. B. Keck, Kay Sakimura

There being no further nominations, the above nominees were elected to office.

President Sakimura relinquished the chair to Dr. Bonnet, the President-elect, and presented the annual presidential address: "Thrips in Relation to Gall-forming and Plant Disease Transmission: A Review."

PAPERS

Dr. Swezey presented two papers: "Synonymy of two common Moths," and "Two new Hawaiian Moths on Chenopodium oahuense." Mr. Zimmerman presented a paper entitled: "A new Phanerostethus from the New Hebrides (Coleoptera: Curculionidae)." For Dr. H. K. Townes, Mr. Van Zwaluwenburg presented a paper entitled: "A Eumenes Wasp and six adventive Ichneumonidae new to Hawaii (Hymenoptera)." Mr. Fullaway presented a paper: "Niihau Insects."

NOTES AND EXHIBITIONS

Coleotichus blackburniae White—Mr. Weber reported that Mr. Maehler and he had collected this pentatomid bug breeding on *Acacia confusa* at Kunia, Oahu on September 30. Former records for this species, all from Oahu are: Tantalus, Manoa arboretum, Konahuanui, "near coast" and "Honolulu, on flowers, mountains." Hosts previously recorded are: *Acacia koa, Dodonaea viscosa* and "imported acacias."

Oxypleurites sp.—It was reported for Mr. Look that a heavy infestation of this eriophyid mite was noted on naio (*Myoporum sandwicense*) at Honuapo, Hawaii, and a lighter one on alahee (*Canthium odoratum*). Mr. H. H. Keifer identified the mites.

Pteromalus puparum (L.)—This pteromalid parasite of the pupa of the cabbage butterfly (*Pieris rapae* [L.]), identified by Mr. Fullaway, was recovered for the first time since 1904 by Mr. Look, who reared it in September from material collected at Kilauea, Hawaii.

Graptostethus servus (Fabr.)—Dr. Williams said that Dr. Swezey and he had observed this lygaeid bug feeding on buds and flowers of the wood rose (*Ipomoea tuberosa*) at the Experiment

Station, H.S.P.A., Honolulu, on November 29. At the base of the calyx of one opened blossom four *Graptostethus* were seen, and at least one had its beak deeply inserted in the fleshy tissue. Other calyces had from one to three bugs upon them, and one bug was found on a bud. Others occurred on the foliage; all were adults.

Draeculacephala sp.—Dr. Williams reported that he and Mr. Van Zwaluwenburg had found the eggs of this cicadellid in watercress (*Roripa nasturtium*) and *Eleusine indica* collected at Waipahu, Oahu on November 25. Small egg clusters of not more than three or four eggs were found deep in the stem tissue of the watercress, but oviposition scars were hardly, or not all, discernible in the watery tissues. In *Eleusine* stems also, collected at the very edge of the watercress patch, egg clusters were found, the egg scars in the grass stems being quite obvious in some cases. The eggs were deeply inserted, and Dr. Williams found a row of seven in one cluster, while another (perhaps more than one oviposition) showed 17. In sugarcane the eggs are often laid in the leaf blade, shallowly inserted. Mr. Pemberton reported finding *Draeculacephala* eggs in Job's tears, and Mr. Van Zwaluwenburg, in the leaf blade of *Chloris inflata.*

Probable parasites of *Ephydra gracilis* Packard[7]—Dr. Williams reported for Mr. Wirth that two pteromalid wasps found crawling over puparia of this ephydrid fly at Iriquois Point, Oahu, had been determined by A. B. Gahan of the U. S. National Museum. They are *Urolepis rufipes* (Ashmead) and *Cytogaster* near *glasgowi* Crawford. This is the first record from the Territory for *Urolepis rufipes.*

Metioche and *Trigonidomorpha*—Dr. Williams reported that some small crickets collected on Oahu were recently determined by Dr. L. Chopard of the Paris Museum. The immature specimens and all the adults with tegmina about as long as the body (but evidently without hind wings) were determined as *Trigonidomorpha sjöstedti* Chopard, originally described from Australia (Ark. Zool., **18a** [6]: 40, 1926). The single fully winged specimen in the lot was identified as *Metioche vittaticollis* Stål.

Recent rearings of these insects by Dr. Williams seem to show that but one species is involved here, namely *Metioche vittaticollis.* Field-collected male and female adults with short tegmina, as well as a large immature male which apparently developed into an adult with short tegmina, were placed in a breeding jar on May 8. They were fed grass pollen, flowers of *Euphorbia* and *Portulaca,* and various odds and ends such as bits of papaya, bread, peanut butter, etc. Young appeared in due time and matured rapidly, so that on July 8 (the field-collected parents having previously been removed

[7] Mr. Wirth's finding of this ephydrid fly is recorded on p. 141.

from the jar) three freshly developed long-winged adults were found. On July 12 there were present in the jar four long-winged adults (one male and three females) and, in addition, one young female with the tegmina neatly rounded at the apex and extending over the abdomen nearly to the base of the cerci. Its ovipositor was relatively short, and the inner wings, or secondaries, showing mesad, were half the length of the tegmina. On about July 21 this individual moulted into a long-winged adult. No other individuals were reared, nor were the parents preserved. The parent crickets lived in captivity up to two months or more, while the young matured in roughly 50 days or less. The egg stage was not determined.

Phytomyza spicata Malloch—Mr. Van Zwaluwenburg exhibited an adult and the work of this agromyzid leaf miner in grass leaves. Its work was first noticed about November 20, 1946, and this is the first record of the species in the Hawaiian Islands. Dr. Swezey captured the first adult on December 8. The fly is widespread on Oahu, having been found from Lanikai to beyond Ewa. It has been found here breeding in the following grasses: corn, *Setaria verticillata,* Johnson grass (*Holcus halepensis*), sorghum, *Eragrostis amabilis,* sour grass (*Valota insularis*), *Eleusine indica, Echinochloa colonum,* a hybrid (Johnson grass X 4n Sudan), *Digitaria* prob. *sanguinalis, Digitaria henryi, Chloris inflata, Panicum purpurascens,* cat-tail millet (*Pennisetum glaucum*), Bermuda grass and redtop (*Tricholaena repens*). *Phytomyza spicata* was first described from Formosa (Ann. Mus. Nat. Hung., **12**: 334, 1914) and is known also from Guam, Samoa and Fiji. Dr. Swezey found it in Guam breeding in corn, *Miscanthus* and Job's tears.

Material collected on Oahu is heavily parasitized. Mr. Fullaway examined these parasites and found three species present: (1) an eulophid, *Hemiptarsenus semialbiclavus* (Girault), the most numerous of the three; the males have branched antennae; (2) another eulophid, *Achrysocharis fullawayi* (Crawford), previously reared from *Liriomyza pusilla* (Meigen) and from several species of microlepidoptera (see Timberlake: Proc. Haw. Ent. Soc., **5**: 440, 1924); and (3) a pteromalid bred from the puparium of *spicata,* assigned with some doubt by Mr. Fullaway to the genus *Merisus. Hemiptarsenus semialbiclavus* is here recorded from Hawaii for the first time; Dr. Swezey reared it from *P. spicata* in Guam. It was described from Australia in the genus *Hemiptarsenoideus* (Mem. Queensland Mus., **5**: 220, 1916).

Additional hosts of *Philaenus spumarius* (L.)—Mr. Davis submitted the following list of plants on which nymphs of the spittle bug were found feeding at Hawaii National Park. This supplements an earlier list presented last year by Mr. Davis and A. L.

Mitchell (Proc. Haw. Ent. Soc., **12**: 515, 1946). All collections recorded in the present list were made in 1946; asterisks indicate indigenous plant species.

Host	Part attacked	Locality	Date
***Ipomoea congesta**	Leaves; stems	Kipuka Puaulu	Jan. 11
Lonicera japonica	Leaves	Residential area	Jan. 22
Brassica oleracea var. gemmifera	Leaves	Quarters 22	Feb. 3
***Styphelia tameiameiae**	Terminal shoots	Park nursery	Feb. 4
***Vaccinium reticulatum**	Terminal shoots	Park nursery	Feb. 4
Oxalis corniculata	Leaves	C.C.C. camp	Feb. 4
***Kokia rockii**	Leaves	Park nursery	Feb. 14
Sambucus sp.	Flower; leaves	Quarters 22	Mar. 25
Acanthospermum australe	Leaves	Sulfur banks	Apr. 11
Tropaeolum sp. (nasturtium)	Leaves	Quarters 22	Apr. 12
Rosa sp.	Leaves	Quarters 22	May 15
***Pipturus** sp.	Leaves	Quarters 22	May 15
Sesuvium portulacastrum	Leaves	Quarters 5	May 15
Lycopersicon esculentum	Petioles	Quarters 22	May 18
***Alyxia olivaeformis**	Stems	Kipuka Puaulu	May 19
***Fragaria chiloensis**	Leaves	Kipuka Puaulu	May 19
Fuchsia arborescens	Leaves	Quarters 22	May 19
Beta sp. (Swiss chard)	Leaves	Quarters 22	June 3
Hedychium coronarium	Leaves	Quarters 22	June 16
Pelargonium graveolens	Leaves	Quarters 5	June 16
Chrysanthemum sp.	Leaves; stems	Quarters 22	June 16
***Sideroxylon** sp.	Terminal shoots	29 Miles	Nov. 22

CORRECTION: *LEPIDOSAPHES NOXIA* McKENZIE

In May, 1946, the author published a description and illustration of *Lepidosaphes noxia* in the Proceedings of the Hawaiian Entomological Society (12[3]: 611-613). Mention was made in the article of a "one-spined" antenna in *Lepidosaphes noxia* which, as now interpreted, is an error. The specimen from which the illustration was made had the additional setae brushed off during the mounting procedure, and two other examples showed a similar condition. Examination of an extended series of paratype specimens indicates at least two unequal antennal setae and in some instances a third more slender one. The correction should be noted in connection with the original description of the species.

As originally described *Lepidosaphes noxia* may be readily separated from closely allied forms now known in the possession of a small dorsal macroduct located slightly anterior to the second pygidial lobes.

Howard L. McKenzie.

Xenopsylla Fleas of the Hawaiian Islands (Siphonaptera: Pulicidae)

By GUSTAF F. AUGUSTSON[1]

(Presented by E. C. Zimmerman at the meeting of March 11, 1946)

There are two known species of fleas representing the genus *Xenopsylla* in the Hawaiian Islands. Of these, *X. cheopis* Rothschild is predominant, and undoubtedly the most efficient vector of plague within these islands (1)[2], as it has proven to be elsewhere.

In 1932, Jordan (3) erected a new species, *X. hawaiiensis,* to hold some fleas which were among a series he received from Dr. C. R. Eskey, U. S. Public Health Service, and Dr. H. R. Hagan, University of Hawaii. These fleas were pooled from rats (*Rattus hawaiiensis*) taken at Honokaa, Hawaii, and on Maui (exact locality not indicated). Jordan (3, p. 264) recognized in his original description of *X. hawaiiensis* that it was possibly only a geographical variety of *X. vexabilis,* a species he described from one pair in 1925 (2). However, in a recent letter (October, 1945) to E. C. Zimmerman, Curator of Entomology, B. P. Bishop Museum, Honolulu, Dr. Jordan indicated that in his opinion *X. hawaiiensis* is a distinct species closely allied to an Australian species—undoubtedly referring to *X. vexabilis* of that country.

After studying many topotypic specimens of *X. hawaiiensis,* the writer considers it to be a synonym of *X. vexabilis.* This view is elaborated upon in the following discussion and accompanying illustrations.

Foremost among the identifying features of members of the genus *Xenopsylla* are the spermatheca in the females, sternite IX and the terminal sclerite of the phallosome of the male genitalia. In Jordan's original description of *X. vexabilis* the spermatheca is not illustrated, but is included for comparison in his original descriptions of *X. hawaiiensis* (3, p. 265). It is noted in these illustrations that the only apparent difference in the two spermathecae is that the upper ventricose portion of the tail is collapsed in *X. vexabilis* but not in *X. hawaiiensis.* In the majority of topotypic females studied by the writer, of *X. hawaiiensis,* the spermatheca had this portion collapsed—a condition probably attributable to the methods of preserving the insect and/or to the subsequent process in preparing a permanent slide. The amount of pigmentation in the tail of the spermatheca is at the same level in both species, as is the amount of extension of the base of the tail below the body.

In regard to males of these two species their identity is likewise specifically the same. For many years the basic taxonomic distinc-

[1] Captain, Sanitary Corps, AUS, on leave of absence, Allan Hancock Foundation, The University of Southern California.

[2] Figures in parentheses refer to the literature consulted, which is listed at the end of this paper.

tion between male members of the genus *Xenopsylla* has been the morphology of the penal tube and the terminal sclerite of its phallosome. Unfortunately these structures do not lend themselves well to a written analysis, and should be illustrated to insure exact identification. This has been done in Jordan's original descriptions for both *X. vexabilis* (2, fig. 9) and *X. hawaiiensis* (3, fig. 19). In comparing the writer's illustration of these structures (fig. 1, *a*) of topotypic males of *X. hawaiiensis* with those by Jordan for *X. vexabilis* and *X. hawaiiensis,* it is apparent that all three are identical.

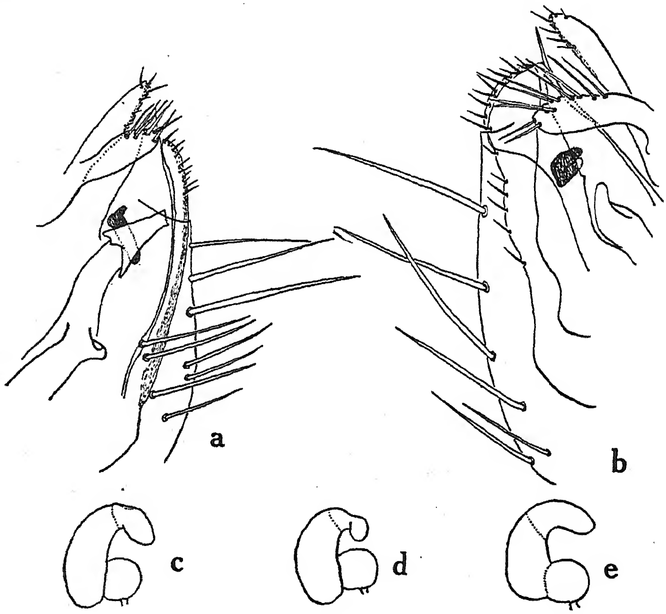

Figure 1.—Details of *Xenopsylla.*

a. *Xenopsylla vexabilis,* male genitalia.
b. *Xenopsylla cheopis,* male genitalia.
c. *Xenopsylla vexabilis,* female spermatheca.
d. *Xenopsylla vexabilis,* female spermatheca.
e. *Xenopsylla cheopis,* female spermatheca.

Particularly important is the exact identity in all three of the short dorsal tooth, with a longer ventral tooth of the ejaculatory duct, and the absence of a semi-detached "dagger" on the terminal sclerite of the phallosome (as is present in *X. cheopis* for instance, fig. 1, *b*). The comparison of other components of the genitalia, i.e. sternite IX, P^1 and P^2 of the clasper, also shows a definite similarity.

The chaetotaxy of the body segments and appendages of *X. vexabilis* was dealt with briefly by Jordan in his original description of

this species, but was discussed extensively on a comparative basis in his description of *X. hawaiiensis*. For ease of comparison, the writer has prepared a table from this description, and from topotypic specimens on hand of *X. hawaiiensis,* showing the relationship of the number of bristles present on the body segments or appendages for this species and on the corresponding ones for *X. vexabilis*.

Table 1. Comparative chaetotaxy of **X. hawaiiensis,** and **X. vexabilis.**

Segment or appendage	Sex	**X. hawaiiensis** (after Jordan)	Topotypic **X. hawaiiensis**	**X. vexabilis** (after Jordan)
Outer lateral surface of hindtibia	♂ ♀	8 to 11	8	7 to 9
Subventral, lateral outer surface	♂	1 to 4	3	2
of hindtibia	♀	4 to 5	3	2
Outer surface of hindtarsus I	♂ ♀	3 to 5	4	3 to 4
Outer surface of sternite VIII	♂	14 to 17	16	13, or fewer
Outer surface of tergite VIII	♀	27 to 33	32	19 (28 to 30*)
Metepimerum	♂ ♀	12 to 14	12	8 to 11
Tergite I	♂ ♀	7-10 or 6-7	7-7	5-6 or 6-6
Tergite II	♂ ♀	15 to 17	15	14 to 15
Tergite III	♂ ♀	16 to 17	16	14 to 15
Sternite III	♂	8 rarely 7	8	6
Sternite IV	♂	8 rarely 7	8	6
Sternite V	♂	7 to 9	7	6
Sternite VI	♂	8 to 10	9	6
Sternite VII	♂	9 to 10	10	6
Sternite III	♀	8 to 10	9	6
Sternite IV	♀	9 to 10	9	7
Sternite V	♀	10	10	8
Sternite VI	♀	10 to 13	12	8
Sternite VII	♀	10 to 12	12	(10*)
P^1 of clasper	♂	6	6	5 or 6
P^2 of clasper	♂	6	6	?

* Number given in original description.

The efficacy of using a descriptive analysis of the chaetotaxy of body segments and appendages for the specific identification of many fleas is a matter of conjecture. The arrangement and number of bristles on certain structures may be fairly constant, whereas on others they may be variable. The differences noted in the above table do not specifically separate *X. hawaiiensis* from *X. vexabilis,* but indicate variability among individuals that actually constitute a single species.

It is noteworthy that *X. hawaiiensis* was not included in Jordan's key to the *Xenopsylla* (4), which was adopted for use in determining members of the genus which are known to be vectors, or potential vectors, of plague. Eskey (1, p. 53) definitely demonstrated

that *X. hawaiiensis* (per se) is capable of transmitting the bacillus of plague as well as being able to subsist for some time on human blood. In view of the fact that Eskey actually was dealing with *X. vexabilis* these findings are of greater importance because of the known wide distribution of this species. It is important that public health workers of the Hawaiian Islands dealing with plague surveys be cognizant of Eskey's findings, and recognize that *X. vexabilis* is not a flea endemic to these islands but actually an exotic species, as is *X. cheopis*, and should be considered with some suspicion in the dissemination of plague. As Eskey (id.) has shown, *X. vexabilis* apparently retains most of its host specificity in the Hawaiian Islands, being found in greater abundance on rats of urban areas, namely *Rattus hawaiiensis*. Pooled rats of this urban species have repeatedly been shown to be naturally infected with the plague bacillus, as have autopsied rats found dead from unknown causes.[3]

The distribution of *X. cheopis* within the Hawaiian Islands parallels its distribution in warmer climates elsewhere in the world. As mentioned previously, it is the predominant species of the genus in these islands, but unlike *X. vexabilis* is found in equal abundance on most species of rats present. *X. cheopis* is easily separated from *X. vexabilis*. The spermatheca of female *X. cheopis* (fig. 1, *e*) has the upper portion of the tail less ventricose than in *X. vexabilis*. Also the base of the tail of the spermatheca in the former species does not protrude beyond its body as it does in the latter species. In male specimens the terminal sclerite of the phallosome (paramere of authors) in *X. vexabilis* is narrow and attenuated, and without a semi-detached "dagger," whereas in *X. cheopis* (fig. 1, *b*) this sclerite is very broad and does have the semi-detached "dagger." The two species can also be distinguished in that sternite IX is scleritized ventrally in *X. vexabilis* and not so in *X. cheopis*.

The writer wishes to acknowledge his appreciation to E. C. Zimmerman of the Bishop Museum for his kindness in the loan of topotypic specimens of *Xenopsylla hawaiiensis* Jordan, and the use of the facilities of his laboratory.

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2. Jordan, Karl, 1925, "New Siphonaptera." Novitates Zoologicae, **32**: 96-112, text fig. 9.
3. ———, 1932, "A new *Xenopsylla* from Hawaii." Novitates Zoologicae, **38**: 264-266, text figs. 19-22.
4. ———, 1943, chapter on Siphonaptera in "A Handbook for the identification of Insects of Medical Importance," John Smart. British Museum (Natural History), London, pp. 202-223, text figs. 128-143.

[3] The reader is referred to reports of the Director, Division of Rodent Control, Board of Health, Territory of Hawaii.

Thysanoptera Hawaiiensis—I

By FRED A. BIANCHI

(Presented at the meeting of October 14, 1946)

Studies on the Thysanoptera of Hawaii during the last few years indicate clearly that the subject is nowhere near exhaustion and that further investigation of it is bound to result in much new knowledge. The share of that knowledge which may result from my own investigations in the future, I propose to publish annually, or at a rate which will not result in papers of unwieldly length. To provide a suitable title indicative of the continuity of these prospective papers, I propose to number them consecutively under the serial name heading this, the first paper of the series.

Here are now presented descriptions of two new and probably endemic Tubulifera from Mt. Haleakala, Maui, and record is made of other recent findings in both the *Tubulifera* and the *Terebrantia*.

Suborder *Tubilifera*
Family *Phloeothripidae* Uzel
Subfamily *Phloeothripinae* Priesner

Haplothrips sesuvii Priesner.

Priesner, Records of the Indian Museum **35**: 363; 1933.

This species has not been previously recorded from the Territory. It was found rather abundant on *Sesuvium portulacastrum* Linn. and on a species of amaranth at Barber's Point, Oahu, on March 12, 1946. Later I was informed by Mr. Kay Sakimura that about the same time the species had been found by him on beach plants along the road between Waialua and Kaena Point, on the windward side of the island.[1] Further search more recently has failed to turn up the species at either of the mentioned localities, but it will probably appear again from time to time.

Halpothrips fissus sp. nov. (Plate I; Figs. A, B, D.)

Female holotype (apterous): Body length 1.36 mm. Color by transmitted light uniformly dark brown; eyes black; subhypodermal pigment red; all major setae light brown.

Head without inter-antennal costa 1.2 as long as wide, widest in middle. Ocelli absent. Eyes small, very slightly protruding, more or less semi-circular in dorsal outline, their ventral aspect smaller and more or less oval, their facets large and regular, five or six along the outer outline of eye, with only 2 or 3 microseteae between them. Cheeks pronouncedly arched from back of eyes to base. Vertex evenly declivous. Postocular setae set back about .6 the eye length from their hind margins; one and a half times as long as the eyes. A row of 4 or 5 minute setae arching along antero dorsal margin of eyes; a

[1] See p. 7.

transverse row of 2 or 3 on vertex; a few others on cheeks. Mouth cone large, broadly rounded at end, not reaching hind margin of mesosternum; labrum not surpassing labium. Maxillary palpi long and thick; labial palpi small.

Antennae almost twice as long as head; inserted very slightly back of vertex; shaped as illustrated. Inter-antennal costa barely surpassing vertex, almost straight in front, only about a fifth as wide as a basal antennal segment. Sense cones tapering but not sharply pointed, one on each side of segments 3, 4, 5, 6, maybe a very thin one dorsally on each of segments 7 and 8, which are broadly joined.

Pronotum as long as head, its fore and hind margins weakly arched, if at all; mid-dorsal suture vestigial medianly; all the usual major setae present, pointed, strong, the coxals equal in length to the antero marginals. Legs normal, with fore femora only slightly incrassate. Fore tarsi with a strong outer and a minute inner claw.

Abdomen, unexpanded and not including tube, more than 1.6 as long as rest of body; narrowing gradually from segment 4 to base of tube; poster angular setae long and pointed on all tergites; sternites 2 to 8 with an intermarginal row of 6 to 10 very minute setae. Major setae of segment 9 nearly 1.5 as long as tube. Tube about 2/3 as long as head, about 2/3 as wide at end as at base, widened abruptly at basal fifth and evenly tapering thence to end. Terminal hairs arranged in usual manner; the strictly laterals on each side extremely long, more than 1.5 as long as tube; those on either side of postero median bifurcate at about distal third.

Measurements of holotype in mm.: Head length .151; head width .131; eye length .041; postocular setae .061; prothorax length .127; antero angular setae .028; antero marginal setae .041; midlateral setae .049; postangular setae .061; epimeral setae .061; coxal setae .041; tube length .094; tube width at base .053; tube width at end .032; lateral terminals on tube .16; dorsal terminals on tube .074 (bifurcate about .021 mm. from terminal end); longest setae on segment 9, .143.

Antennal segments	1	2	3	4	5	6	7	8	Total
	.032	.045	.036	.036	.041	.036	.036	.024	.286

Described from the holotype, collected by E. C. Zimmerman on April 28, 1945, near Puu Luau (5,500 ft. elev.) on Mt. Haleakala, Maui. The male is unknown.

This new species is in all other respects a typical *Haplothrips,* but the unique bifurcation of the dorso lateral terminal setae at once distinguishes the species from all other members of the genus, both in Hawaii and elsewhere. This character has suggested the specific name "fissus," split.

LEGEND FOR PLATE I

A *Haplothrips fissus* sp. nov. Right antenna of apterous female with all setae omitted.

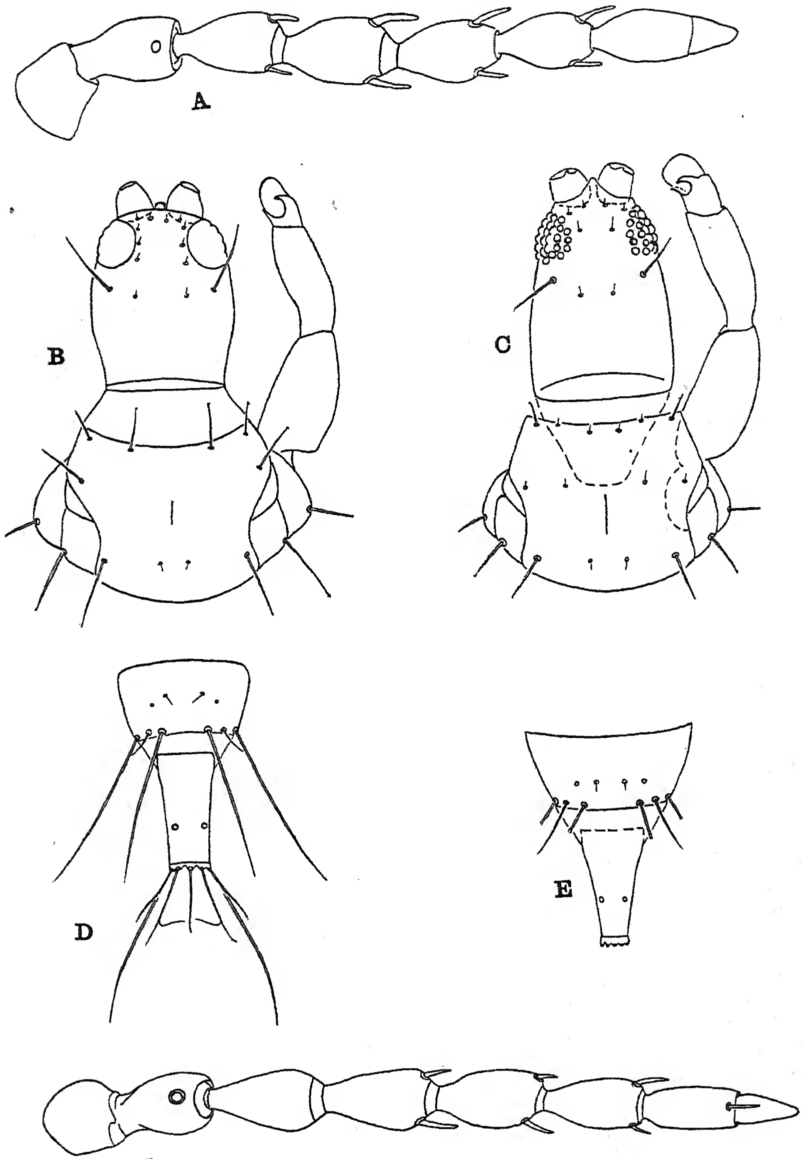
B *Hoplothrips fissus* sp. nov. Head, prothorax and right fore leg of apterous female, with some minor setae omitted.

C *Pseudocryptothrips remotus* sp. nov. Head, prothorax and right fore leg of apterous female.

D *Haplothrips fissus* sp. nov. Ninth and 10th abdominal segments of apterous female, showing bifurcated setae.

E *Pseudocryptothrips remotus* sp. nov. Ninth and 10th abdominal segments of apterous female, with setae omitted or abbreviated.

F *Pseudocryptothrips remotus* sp. nov. Right antenna of apterous female, with setae omitted.


A
B
C
D
E
F

Pseudocryptothrips remotus sp. nov. (Plate I; Figs. C, E, F.)

Female holotype (apterous): Body length 1.2 mm.; color by transmitted light dark brown; base of antennal segment 3, tarsi, and extreme end of tibiae, particularly on fore legs, lighter. Eyes black. Subhypodermal tissue red.

Head distinctly produced in front of eyes, from base to anterior corner of eyes 1.4 as long as wide, widest at about posterior fourth; cheeks weakly arched and distinctly divergent to posterior fourth, thence almost parallel; vertex flat, evenly declivous. Ocelli lacking. Eyes small, between a third and a fourth of cheek length, protruding only posteriorily, with inner posterior angle broadly rounded; the facets irregular in shape and without microsetae among them; eyes in ventral aspect similar in shape but smaller than in dorsal aspect. Postocular setae .75 as long as eye, set about .5 the eye length from their posterior margin and about same distance from cheek. A pair of minute setae between eyes on transverse median line; other microsetae on vertex and cheeks. Mouth cone rounded at end and .5 as long as head exclusive of part produced in front of eyes; maxillary palpi relatively small; labial palpi almost minute; labrum not surpassing labium.

Antennae 1.6 as long as head, shaped as illustrated; inter-antennal costa straight in front and only .25 as wide as a basal antennal segment; setae and sense cones colorless, thin, inconspicuous; sense cones tapering to blunt point, none on segment 3, one on each fore angle of segments 4, 5, 6, one dorsally on segment 7. Segment 8 not pedicillate but narrower than segment 7.

Pronotum ⅞ as long as head and about 1.12 as wide as head length. Paired setae on posterior prothoracic angles about equal to post oculars; those on anterior angles and the coxals little more than half as long; other setae minute. Mid-dorsal suture medianly vestigial. Legs normal; fore legs not incrassate; fore tarsi with small, sharp, inner and outer claws.

Abdomen, unexpanded and not including tube, more than 1.5 as long as rest of body; about equally wide from base to segment 6, narrowing evenly from segment 7 to base of tube. Tube about .6 as long as head, about twice as wide at base as at end, tapering more rapidly from basal fourth, which is sculptured with faint anastomosing lines. All abdominal setae pale and weak; those on segment 9 somewhat longer than tube and about equal to longest terminals on tube. Sternites 2 to 7 with a median transverse row of 6 to 10 minute setae.

Measurements of holotype in mm.: Head length .178; head width .123; post ocular setae .036; prothorax length .143; prothorax width .188; antero angular setae .02; postangular and epimeral setae .036; tube length .09; tube width at base .06; tube width at end .03; lateral terminals on tube .11; dorso lateral setae on abdominal segment 9, .10.

Antennal segments	1	2	3	4	5	6	7	8	Total
	.020	.041	.036	.041	.041	.041	.036	.020	.276

Described from the holotype and two female paratypes found by E. C. Zimmerman resting on a species of Dubautia, on the crater rim of Mt. Haleakala, Maui, on April 25, 1945. The male of the species is unknown.

Only two other species of *Pseudocryptothrips* have been described: the genotype, *P. meridionalis* Priesner, from South Europe, and *P. proximus* Faure, from South Africa. While obviously congeneric with these two species, which according to description are very nearly alike, *remotus* differs from them in several respects: mainly in being of uniformly brown color, in having smaller and more numerous eye facets, in having no sense cones on antennal segment 3, and in possessing only pointed setae. This

comparatively distant relationship to the other members of the genus has suggested the specific name "*remotus*."

Suborder *Terebrantia*
Family *Aeolothripidae* Uzel

Aeolothrips fasciatus Linn.

This species is not common in the Territory. It has been previously recorded from occasional collections on Oahu and from one collection by Dr. O. H. Swezey on Mt. Haleakala, Maui, but is here recorded for the first time from the island of Hawaii. E. C. Zimmerman and the author found it unusually abundant by beating grasses and ferns at Humuula and at Kilauea, on August 3, 4, and 8 of this year.

Family *Thripidae* Usel

Hercothrips fasciatus Pergande

This potential pest appears now to be firmly established in the Territory, where it is now known from Molokai, Hawaii, and Oahu. It was first found on Oahu by J. S. Rosa and the author at Barber's Point on February 20, 1946, feeding on *Heliotropium curassavicum*. Since then it has been recorded by Mr. Sakimura on the same host and on *Sonchus oleraceus* on the windward side of the island, at Kaena Point. The list of hosts from which the species has been recorded in the Territory comprises only the weeds *Argemone glauca*, *Sonchus oleraceus* and *Heliotropium curassavicum*, and as yet includes no cultivated plants. It is interesting to note that on the island of Hawaii the species has been collected on the first two hosts at Naalehu, only 200 feet or so above sea level, and on the Saddle Road, at an elevation of approximately 6,000 feet.

Chirothrips patruelis Hood

Revista de Entomologia, **11**: 550, 1940.

In a recent paper ("Additions to the Thysanoptera from the Island of Hawaii"; Haw. Ent. Soc., **12**: 503, 1945) I recorded the presence of *Chirothrips mexicanus* Crawford on the island of Hawaii. On further study of the material originally available, and on comparison of it with much additional material which I have since obtained, I am now forced to amend that record. *Chirothrips mexicanus*, it appears now, has not been collected on the island of Hawaii. The two species of the genus which have been collected there are *Chirothrips fulvus* Moulton, which is evidently quite scarce, and *Chirothrips patruelis* Hood which is abundant.

Chirothrips patruelis has not been previously recorded from the Territory. In addition to the specimens recorded as *C. mexicanus*

(loc. cit.), I now have a long series of the species collected by E. C. Zimmerman and myself by beating grasses at Kilauea and Humuula, early in August, 1946.

Plesiothrips panicus (Moulton)

During August of this year I found one female of this species on Sudan grass, at Naalehu· Hawaii. This constitutes a new island record for the species.

The Distribution of Mosquito Breeding by Type of Container in Honolulu, T. H.*

By DAVID D. BONNET
Acting Director, Division of Mosquito Control, Board of Health

(Presented at the meeting of November 18, 1946)

During the late summer of 1943, because of the outbreak of dengue fever, there was established in Honolulu a mosquito control unit under the auspices of the Board of Health of the Territory of Hawaii, with funds and personnel supplied by the Honolulu Chamber of Commerce, the U. S. Public Health Service, and the U. S. Army. In the Territory of Hawaii, there are three species of mosquitoes: *Aedes aegypti* (L.), *Aedes albopictus* (Skuse), and *Culex quinquefasciatus* Say. Both of the *Aedes*, or "day-biting" mosquitoes, are known vectors of dengue fever (Cleland, J. B., Bradley, B., and McDonald, W., 1916; Chandler and Rice, 1923; Siler, Hall, and Hitchens, 1924; and Simmons, St. John, and Reynolds, 1930); hence, the primary function of the mosquito control unit was to inspect for and, eliminate the breeding places of the *Aedes* mosquitoes. Incidental to this primary function, samples of mosquito larvae were collected which serve as the basis for this paper. Acknowledgment is made to the many mosquito control inspectors who gathered the larval mosquito samples.

Previous studies on the bionomics and more particularly the breeding places of these species have been made in other areas by Liston and Akula (1913), MacFie (1915), Senior-White (1934), Sen (1935), Robertson and Hu (1935), and Wijesundara (1942). Studies of breeding preferences have been made in relation to various physical factors, including salinity (Woodhill 1938, 1941), hydrogen-ion concentration (Senior-White, 1926), organic nitrogen concentration (Beattie, M.V.F., 1932), and "water-finding" (Kennedy, 1942). Van Dine (1904), Williams (1944), and Usinger (1944) have studied and reported on the biology of the three species of mosquitoes in Hawaii.

Although it has been generally known that *Aedes albopictus* and *Aedes aegypti* breed primarily in domestic containers, more information was desired on the distribution of *Aedes* breeding in Honolulu. To obtain this information, a census was taken for a period of 22 months, not only of the places where *Aedes* mosquitoes were found breeding, but also of the numbers of all types of possible or potential breeding containers. Since a mosquito control inspec-

* Presented as a lecture in short form at the Hawaiian Academy of Science, November 7, 1946, University of Hawaii, Honolulu, T. H.

tor inspected all premises in the city of Honolulu at least once every four weeks, this census is fairly accurate with reference to area coverage. However, among a large number of different individuals there are certain variations in the manner of counting. The resulting variations in recording were somewhat reduced by the fact that the inspectors were rotated from area to area, which would tend to level out these differences. Perhaps, the most serious error lies in the fact that a large accumulation of bottles or tin cans in one location was considered not in absolute numbers but as "more than 10" or "10 plus." The result was a reduction in the absolute numbers of these containers recorded and hence, a reduction in the apparent percentage with respect to other containers. This error is not as bad as it would appear since the same method was used in all cases of both breeding and non-breeding situations and thus tends to balance the results, enabling one to make a satisfactory comparison.

The distribution of "potential" or "possible" mosquito breeding containers in the city of Honolulu is presented in Figure 1. These percentages are based upon a total count of 4,450,041 containers and show the relative importance of the different categories. The group entitled "others" includes such miscellaneous possible breeders as tarpaulins, odd pieces of junk, tree holes, roof gutters, etc. Interior containers include all those used for flower or plant holders inside dwellings, such as vine bowls and flower vases. The ape plants (*Alocasia macrorrhiza* var.) and lily plants, including pineapple lily (*Bilbergia thyrsoidea*) and the spider lily (*Crinum asiaticum*), are found in approximately equal numbers and are potential mosquito breeders owing to the water retained in the leaf axils. The other groups are self-explanatory.

The distribution of "actual" breeding, according to the same classifications, is presented in Figure 2 and is based upon 41,226 samples of *Aedes* larvae. A comparison of Figures 1 and 2 shows that most of the containers have a different importance when considered from the standpoint of breeding. For example: although *barrels* constituted only 8.4% of all containers, we find that they contained 10.7% of all discovered *Aedes* breeding. Similarly, although the *ape* and *lily plants* were approximately equal in number, constituting 7.4% and 7.1% of the breeding sources respectively, the *lily plants* are more important as breeders since 12.6% of all breeding was found in this type of container, whereas *ape* plants contained only about 4%. Records reveal an interesting correlation between the type of container and the amount of mosquito breeding. In *interior containers* which constituted 10.9% of all containers examined there was found 10.6% of all mosquito breeding recorded.

The most extreme difference to be noted between number of containers and amount of breeding found in them is that of the

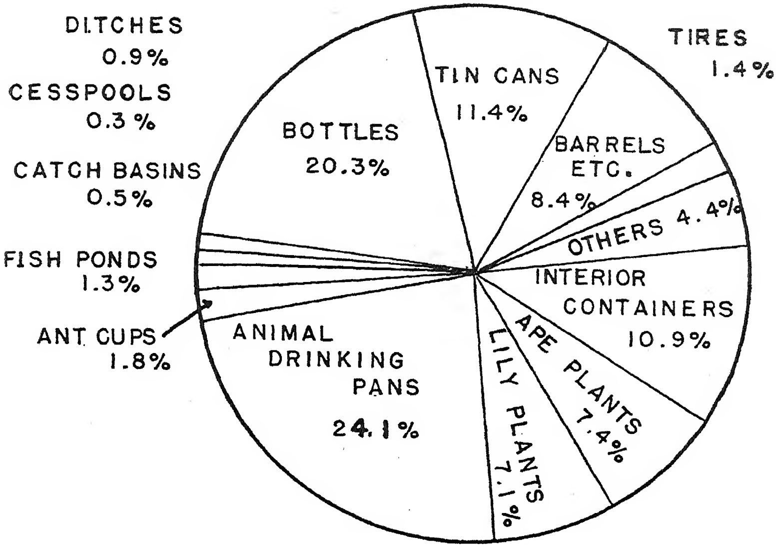


FIG. 1

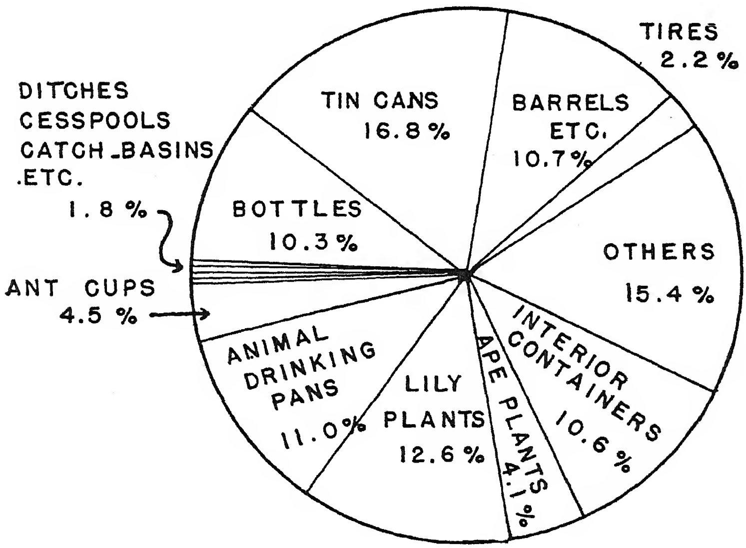


FIG. 2

Figure 1.—Distribution of containers in Honolulu according to container type.
Figure 2.—*Aedes* mosquito breeding in Honolulu according to container type.

miscellaneous group labeled "others." Although this group was reported as only amounting to 4.4% of the containers in the city, they contained 15.4% of all mosquito breeding. This great difference may be somewhat fictional since this group includes breeding found in containers that one would seldom count as a "potential" or "possible" breeding container, such as an old shoe, boats, tarpaulins, pipe fence posts, and a hundred other locations. Since it is known that breeding may occur in almost any location that will hold water for from 10 to 14 days, this not surprising.

The preceding information is presented graphically in Figures 3 and 4. These graphs merely group the different types of containers to show the relative number of container types and the relative amount of breeding respectively, according to the larger classifications used in control operations. The *accidental containers* include all unnecessary incidental types of containers, such as bottles, tin cans, barrels, tires, etc. The *interior containers,* which may be considered semi-useful, include flower vases and vine bowls; *outdoor plants* include *ape* and lily plants; *semi-permanent useful containers* include animal drinking pans and ant cups, while *permanent useful containers* include cesspools, fishponds, sumps, and ditches.

If *Aedes* mosquito breeding occurred at random in all types of containers, one would expect that the distribution of mosquito breeding would be in the same proportion as the relative numbers of containers; that this is not the case is indicated by comparison of the above figures and is an indication that these mosquitoes show definite preferences for the places that they choose to lay their eggs.

Further evidence of such preference is presented in Table 1, which lists the percentage of a random sample of each of the three species found in Honolulu according to the container in which they were found. This table is presented according to rank for *Aedes albopictus,* and immediate differences may be noted when this column is compared with the columns for *Aedes aegypti* and *Culex quinquefasciatus.* In examining these data, allowance must be made for the fact that the information has been gathered during regular inspection-control operations by a large number of different individuals and that certain errors in recording data were made. This is particularly true in the case of *Aedes* larvae being reported in ditches and ground pools. Investigation of all reported instances showed that only rarely was there an actual case of breeding in an earth-lined container. Usually the apparent presence of mosquito breeding there occurred as a result of a bucket, tin can, or bottle which contained breeding mosquitoes having been emptied into the outdoor pool by the householder in anticipation of the inspector's visit when he was observed next door. These data are, therefore, useful only in a relative way and permit only an approximation of the differences in preference of *Aedes aegypti, Aedes albopictus,*

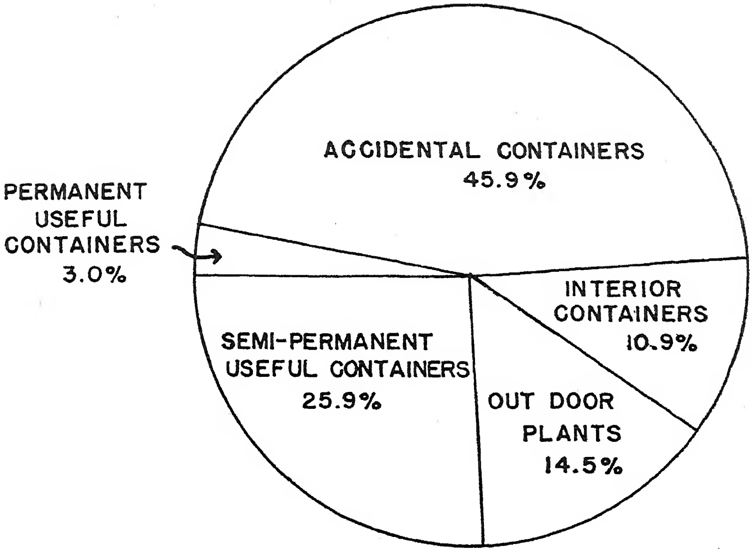


FIG. 3

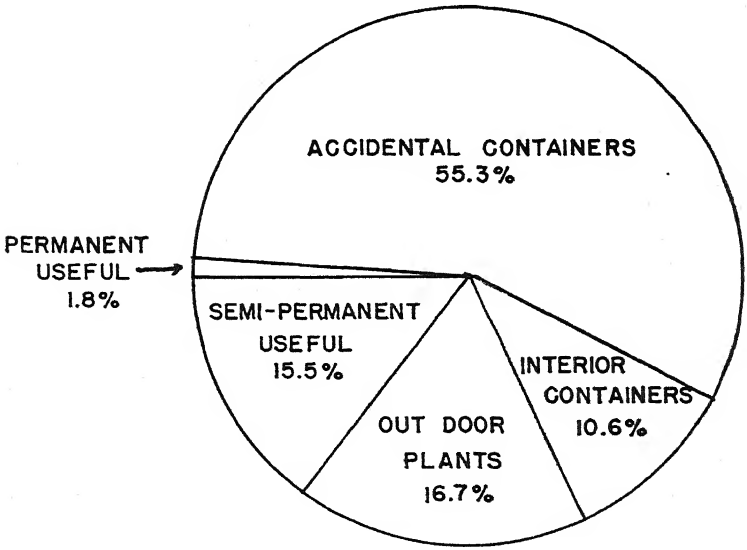


FIG. 4

Figure 3.—Distribution of containers in Honolulu according to container type.
Figure 4.—*Aedes* mosquito breeding in Honolulu according to container type.

TABLE I

Distribution of Mosquito Breeding By Species According to Container 1944 — 1945

Containers	Aedes albopictus	Aedes aegypti	Culex quinquefasciatus
No. of Samples	1014	922	924
Tin cans	19.4%	13.4%	16.2%
Flower vases	13.0	11.9	0.0
Lily plants	10.7	1.4	1.1
Vine bowls	7.8	6.9	.9
Pans	7.4	11.6	5.9
Bottles	6.5	9.9	1.4
Buckets	5.9	13.7	13.7
Jars	4.4	0.0	1.5
Ant cups	4.1	5.6	.3
Ape plants	3.9	2.0	0.0
Tree holes	3.7	1.8	0.0
Rock holes	2.1	0.9	0.0
Tires	1.5	2.9	1.5
Barrels	1.3	3.4	10.1
Fish ponds	1.1	2.3	7.0
Pipes	1.1	0.0	0.0
Bird baths	.7	.2	.3
Toilet bowls	.6	1.2	0.0
Ground pools, ditches	.6	.9	19.7
Bamboo stumps	.6	0.0	0.0
Tanks	.5	1.4	1.0
Coconut shells	.2	0.0	.1
Cesspools	.1	.2	1.2
Catch basins	0.0	2.8	2.7
Tubs	0.0	5.0	4.1
Boats	0.0	.4	1.4
Machine parts	0.0	.1	0.0
Streams	0.0	0.0	.4
Swamps	0.0	0.0	2.5

and *Culex quinquefasciatus* for breeding places. It is interesting to note the comparative rank of the four most common container types found breeding the different species as listed below:

Aedes albopictus	Aedes aegypti	Culex quinquefasciatus
Tin cans	Buckets	Ditches and ground pools
Flower vases	Tin cans	Tin cans
Lily plants	Flower vases	Buckets
Vine bowls	Pans	Barrels

Tin cans are of prime importance for all three species. *Aedes albopictus* and *Aedes aegypti* have a high degree of common preference. Although *Culex quinquefasciatus* shows a high degree of difference in its preferences, it appears more closely related to *Aedes aegypti* than to *Aedes albopictus* in its breeding habits. This

may be seen strikingly in the fact that *Aedes albopictus* was not found in catch basins, while *Aedes aegypti* and *Culex quinquefasciatus* were found there with about the same frequency.

These figures, graphs, and charts have a practical value in the operation of a mosquito control program. Although the data have certain limitations of analysis owing to the manner of collection, they emphasize the importance of all types of "accidental containers" as places for the breeding of the species of mosquitoes found in the city of Honolulu.

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Niihau Insects

By D. T. FULLAWAY

(Presented at the meeting of December 9, 1946)

In the early part of October, 1945, Stephen Au and Q. C. Chock visited the island of Niihau, off the southwest coast of Kauai, for the purpose of making an entomological survey. In the four or five days spent on the island they collected the insects listed below. Although this list is small, it constitutes a beginning to which it is hoped additions will be made later as further opportunities occur to visit this little-frequented island. It may never be extended greatly, as it is well known that continued grazing by cattle and sheep has long since denuded whatever forest cover was on this low island, and under the circumstances a great variety of insects cannot be expected.

The abbreviations following the names of the various species refer to the authorities for the identifications: OHS, O. H. Swezey; FXW, F. X. Williams; ECZ, E. C. Zimmerman.

ORTHOPTERA

Pycnocelis surinamensis (L.), FXW
Diploptera dytiscoides (Serville)
Atractomorpha ambigua Bolivar
Conocephalus saltator (Saussure)
Metioche vittaticollis Stål, ECZ

ISOPTERA

Cryptotermes piceatus Snyder

DERMAPTERA

Labidura riparia (Pallas), ECZ

ODONATA

Enallagma civile (Hagen), ECZ

ANOPLURA

Haematopinus suis (L.)

Proc. Hawn. Ent. Soc., Vol. XIII, No. 1, May, 1947.

HOMOPTERA

Saissetia nigra (Nietner)
Lepidosaphes sp.
Pulvinaria sp.

HETEROPTERA

Nysius fucatus Usinger, ECZ
Zelus renardii Kolenati

LEPIDOPTERA

Anacamptodes fragilaria (Grossbeck), ECZ
Omphisa anastomosalis (Guenée), ECZ
Celerio lineata (Fabricius), ECZ
Polydesma umbricola Boisduval, OHS
Feltia dislocata (Walker), OHS
Omiodes demaratalis (Walker), OHS
Hypsopygia mauritialis (Boisduval), OHS
Stoeberhinus testaceus Butler, OHS
Laphygma exempta (Walker), OHS
Thyrocopa sp., OHS
Euchromius ocelleus (Haworth), OHS

COLEOPTERA

Gonocephalum seriatum (Boisduval)
Cyclonotum extraneum Sharp, ECZ
Carpophilus humeralis (Fabricius), ECZ
Dermestes vulpinus Fabricius
Amphicerus cornutus (Pallas), ECZ
Necrobia rufipes (Degeer)
Cryptolaemus montrouzieri Mulsant
Coelophora inaequalis (Fabricius)
Curinus coeruleus Mulsant, ECZ
Azya luteipes Mulsant, ECZ
Rhizobius ventralis (Erichson), ECZ
Platyomus lividigaster Mulsant, ECZ
Ceresium unicolor (Fabricius)
Prosoplus bankii (Fabricius)
Diachus auratus (Fabricius)
Bruchus amicus Horn, ECZ
Bruchus prosopis LeConte, ECZ
Megacerus alternatus (Bridwell), ECZ
Araecerus fasciculatus (Degeer)
Pantomorus godmani (Crotch)
Oxydema fusiforme Wollaston, ECZ

HYMENOPTERA

Evania appendigaster (L.)
Leptogenes falcigera F. Smith
Pachodynerus nasidens (Latreille)
Campsomeris marginella modesta Smith
(*Scolia manilae*)
Brachymeria obscurata (Walker)
Trypoxylon bicolor Smith, ECZ

Amblyteles koebelei (Swezey), ECZ
Megachile fullawayi Cockerell, ECZ
Odynerus soror Perkins, ECZ
Anoplius luctuosus (Cresson), ECZ
Pison hospes Perkins, ECZ
Silaon rohweri Bridwell, ECZ
Urosigalphus bruchi Crawford, FXW
Stomatoceras pertorvum Girault

DIPTERA

Volucella pusilla Macquart
Gastrophilus intestinalis (Degeer)
Omphrale lucidus (Becker), FXW
Chrysomyia megacephala (Fabricius), FXW
Archytas cirphis Curran, FXW
Chaetogaedia monticola (Bigot), FXW
Helicobia helicis (Townsend), FXW
Cryptolucilia caesarion (Meigen), FXW
Ophyra nigra Wiedeman, FXW
Hystriocnema plinthopyga (Wiedeman), FXW

A New Species of the Dipterous Family Asteiidae from Hawaii

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The family Asteiidae is one of the smallest and least common of the acalyptrate Diptera, and is poorly represented in most collections. It is therefore always of interest to record a new species in the group.

In 1901, Grimshaw (Fauna Hawaiiensis, 3, pt. 1. Diptera, pp. 73-74) described two new species of *Asteia* Meigen from the Hawaiian Islands, *Asteia hawaiiensis* and *A. apicalis*, and recorded a third merely as "*Asteia* sp." From his notes on the last, especially his statement that "the arista appears to be quite bare," it is fairly certain that he had the species which is herein described as new. His specimen was recorded as "beaten from trees, at a height of 3,000 ft. in the Waianae Mts., Oahu," and it will be noted that both of the present specimens were also taken on Oahu, one of them at 4,000 feet on Mount Kaala (Waianae Mts.).

Asteia nudiseta, new species.

Black-brown and yellow species, distinguished from all other known species of the genus by having the combination of three pairs of dorsocentral bristles and a bare antennal arista.

Female.—Head predominantly shining black, the front anteriorly brown, the narrow cheeks whitish yellow except for black margin, and the lower half of the face with a broad silver-white crossband extending from eye to eye. Proboscis and palpi yellow. Antennae and the slender bare aristae black, the third segment dusky yellow on the lower fourth. Front broad, equal to one-half the width of the head. Bristles black, the oral vibrissae, inner and outer vertical bristles, and the one pair of fronto-orbitals very long and slender, the latter situated slightly in front of a line drawn through the median ocellus; proclinate divergent ocellar bristles distinct though somewhat shorter than the above; postverticals minute.

Thorax black, with a broad yellow fascia extending on a slight diagonal across each pleuron from the fore coxa to the base of the wing, the hypopleuron and a narrow upper margin of the sternopleuron, brown to yellow. Scutellum black with apical yellow spot between the bases of the widely separated apical scutellar bristles. Mesonotum shining black, only a broad median stripe between the dorsocentrals, and also the scutellum, sparsely pollinose. Chaetotaxy: Notopleurals 1 + 2, 1 postalar, 3 dorsocentral (one of them anterior to the suture), and 1 apical scutellar, all long and strong except the posterior notopleurals, which are short and spinelike; one pair of subapical scutellars, short, hairlike, and very inconspicuous (obviously over-

looked by Grimshaw in his notes on the genus, p. 73). Upper margin of the sternopleuron with three or four hairs, but only the posterior one is developed as a sternopleural bristle.

Abdomen yellow below and on the sides, the dorsum dull brown with two broad brown bands extending ventrad, apparently on the third and fourth segments. Distal segments shining black.

Legs predominantly yellow, marked with black as follows: Distal portion of all femora, including less than one-fourth of the fore, about one-half of the mid, and slightly over half of the hind femora; the bases of all tibiae slightly; and the distal segment and claws of all tarsi. Empodium notably long and curved.

Wings hyaline, veins brown, venation as figured for *Asteia* in Curran's Manual (1934, p. 328, fig. 3), except that the apical cell is slightly narrower at the margin of the wing, and the submarginal cell slightly but distinctly broader than the widest part of the first posterior cell. Knob of the halteres black, the stalk yellow.

Length 2.5 mm.

Holotype, female, Mount Kaala, Oahu, July 25, 1946, "el. 4,000 ft., bog at summit" (W. W. Wirth). Paratype, female, Oahu (J. C. Bridwell). Type No. 58218 and paratype in the United States National Museum.

The only described species in the Pacific area which might be confused with *nudiseta* is *Asteia atriceps* Malloch (1932, Bernice P. Bishop Mus. Bul., 98: 115), described from Hivaoa in the Marquesas. That species, however, has four pairs of dorsocentral bristles (one before and three behind the mesonotal suture), only one posterior notopleural bristle, all yellow bristles, and a large prescutellar yellow spot on the mesonotum.

The two species might well be considered entitled to generic segregation from typical *Asteia*, based on the bare arista, as Malloch (op. cit.) has already observed. I believe that they are the only two known species of *Asteia* to possess that character. *Asteia decepta* Becker (Canary Islands), included with them by Malloch, is on the contrary a species with an intermediate type of arista (like *A. apicalis* Grimshaw, q. v.), in which the fundamental zigzag structure is present but only weakly developed and the aristal branches are short and can be seen only with high magnification. Aside from the type of arista, however, the species are so similar to the usual *Asteia* that I agree with Malloch in leaving them in the genus.

Asteia apicalis Grimshaw.

Three female specimens agree with Grimshaw's description and are here recorded as that species (Kilauea, Hawaiian National Park, August 10 and September 1946, in light trap, coll. W. W. Wirth, C. J. Davis). The arista is almost straight, as he noted, and the aristal branches are microscopic, but even so the arista is distinctly of the zigzag type and not the slender, straight, bare form

of *nudiseta.* The specimen before me has only two pairs of long, erect, dorsocentral bristles, the mesonotum is more thickly pollinose, and the yellow stripe on each pleuron is wider than in *nudiseta,* the knob of the halteres is partly yellow, and the abdomen has a brown dorsum and yellow sides and venter, without any brown bands extending ventrad from the dorsum.

Thrips in Relation to Gall-forming and Plant Disease Transmission: A Review[1]

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(Presidential address, delivered December 9, 1946)

INTRODUCTION

Thrips are involved in several types of host relationship with plants, besides inflicting mechanical feeding injuries. Gall-forming and plant disease transmission are two such special host relationships. An attempt is made in this paper to summarize all the available information regarding these two topics.

Thrips are one of the well-known gall-forming insects, and the field has been fairly well studied. Most of the contributions have been made in the earlier years and little current work is known; references are briefly reviewed here. Galls are essentially a special type of toxaemia caused by insect toxin, and thus gall-forming is referred to as a phase of insect transmission of plant diseases. Study in the field of plant disease transmission by thrips has made rapid advancement in recent years and quite a large volume of references is available. The field was briefly reviewed about 10 years ago by Bailey (1935) and additional published information was assembled by Sakimura (1937). A large series of new references has been accumulated in the past 10 years and these are all available for the present review to make it as comprehensive as possible. Many old references not cited in the two former reviews, particularly on the subject of negative results of transmission tests, have been freely incorporated in this paper.

SUMMARY

Many thrips galls have been recorded, mainly from the tropic and subtropic regions. The common type of thrips galls is leaf-roll or its modified forms, a simple form, but a few other types, more complicated in structure and more advanced in development, are also known to be produced by thrips.

The available knowledge on toxaemias caused by thrips is far from complete.

Several cases each of bacterial and fungous diseases have been reported to be transmissible by thrips. Knowledge of these groups

[1] Published with the approval of the Director as Miscellaneous Paper 44 of the Pineapple Research Institute, University of Hawaii.

[2] Grateful acknowledgment is due to Dr. Walter Carter who read the manuscript.

is also incomplete and the spread of many more diseases might be related to thrips. These diseases are rather easily disseminated by thrips.

As many as 41 different viruses have been tested for their vector relation with various species of thrips but none were in a positive relationship except the single case of the spotted wilt virus. There is another case but presentation of the evidence is incomplete. The spotted wilt virus is transmissible by three different species of thrips; some other species might be additional vectors. Thrips are unlikely to be the vectors for the viruses which are transmissible by other groups of insects. Additional thrips-transmissible viruses may possibly be found among a group which are parenchyma or sap-transmissible type but known to be not transmissible by any other group of insects.

Hawaii is subject to possible invasions of the second and third vector thrips of the spotted wilt virus; one of the three vectors has established well in Hawaii. This is a situation calling for protective measures to prevent such invasions which would increase destructiveness of the spotted wilt disease in Hawaii.

Part I: GALL-FORMING

The plant gall consists of deformed tissues produced by plants upon the stimulus induced by feeding of the gall insects. The toxin theory has been advanced for the origin or mechanism of the stimulus induced by insects. In other words, such galls are referred to be a special type of toxaemia caused by toxin secreted and injected by the gall insects at the time of feeding. However, a few of the insect galls appear to be of traumatic origin. Some simple forms of the thrips galls are suspected of belonging to this group. More common gall-formers are gall-mites, gall-midges, and gall-wasps, all of which produce well-defined galls. Thrips are, however, minor and rather primitive gall-formers. The most common types of thrips galls are leaf rolls, leaf folds, and leaf wrinkles. These types are more or less characteristic of the thrips galls. Highly developed galls, as commonly seen among those produced by other gall insects, are very rare among the thrips galls. The few such cases reported are bladder and pouch galls, horn galls, bud galls, and stem galls. No root gall produced by thrips has been reported yet.

The outstanding contributions in the field of thrips galls are the works of Bagnall (1928, 1929), Docters van Leeuwen-Reijnvaan (1926), Karny (1911, 1913), and Karny and Docters van Leeuwen-Reijnvaan (1913, 1914-1916).

The distribution of the thrips galls is more or less limited within the tropic and subtropic regions, particularly the palaeotropic regions. Its abundance is particularly noticeable in the Indo-Malay-Australian regions. A limited number of cases have also been

reported from the Mediterranean and North African region and the Oceanic region. The major reference on the Oceanic region is that of Bagnall (1928) which dealt with the Samoan and Tongan thrips.

In Hawaii, the collectors have made some effort but no true gall-forming thrips[3] have yet been discovered. It appears that Hawaii is remote from the outer fringe of the central region where the evolution of gall-forming thrips has been highly developed. Incidentally, even the widely distributed *Ficus* gall thrips, *Gynaikothrips ficorum* (March.) and *G. uzeli* Zimm., are not present in Hawaii. The genus *Ficus* is entirely absent in the Hawaiian native flora, although several common species including *F. retusa* Linn. and *F. Benjamina* Linn. have been introduced in the recent years.

The thysanopterous fauna in the neotropic regions appears poor in gall-forming thrips and only few galls have been known. Several cases reported from North America are doubtful as to whether the thrips recorded are the true gallers or not. A good number of galls caused by the ordinary herbivorous terebrantian species were reported from Europe (Wahlgren, 1945).

The majority of gall-forming thrips belong to the suborder Tubulifera, but a few terebrantian species are also involved in gall-forming. Among Terebrantia, 10 species, which all produce simple forms of gall, belonging to three genera have been recorded from Dutch East Indies (Docters van Leeuwen-Reijnvaan, 1926); 17 species belonging to seven genera have been recorded from Europe (Wahlgren, 1945). Among Tubulifera, taxonomic range of the galler is strictly limited to the Phlaeothripinae, and practically every species belongs to Hoplothripini or Haplothripini. Very few belong to Idolothripini, Histricothripini, and Phlaeothripini, which are all rather primitive or poor gallers. As far as the reviewer is aware, there are about 110 species belonging to 25 genera of Hoplothripini and about 35 species belonging to 13 genera of Haplothripini. The predominating genera are of the *Gynaikothrips-Smerinthothrips* group.

Association of the inquilinous thrips is a very common occurrence in many thrips galls and also in the galls produced by other origins. A differentiation between the true galler and the friendly inquiline or predaceous invader has not always been recorded in the references. Consequently it is difficult to segregate them. However, it appears that a fairly good percentage of the 145 species of Tubulifera aforementioned must be the non-gall-forming species. The available indications suggest that some of the Hoplothripini group and the majority of the Haplothripini group belong to the non-gall-forming species, and the true gallers are more or less limited to the Hoplothripini. Diversity of the host plants on which thrips produce the galls is well noted, and the range includes Pteridophyta, Gym-

[3] Malformations on foliage or terminals as a result of heavy mechanical injuries caused by the ordinary herbivorous terebrantian species were rarely observed.

nospermae, Dicotyledones, and Monocotyledones. The shape of galls in minute details are usually specific to the host plant on which the galls are produced and also to the thrips by which the galls are produced. In some cases, the same species of thrips produces different shapes of gall on the different species of plant; different species of thrips produce different shapes of gall on the same species of plant.

The most familiar and widely distributed thrips gall of the leaf-roll type is the one on *Ficus*. Ten species of *Gynaikothrips* and two species of *Smerinthothrips* have been recorded as responsible for gall formation on the various species of *Ficus* throughout the world. *G. ficorum* (March.), which more or less specifically feeds on the widely distributed *Ficus retusa*, is the cosmopolitan species (Priesner, 1939) and the rest are more or less regional species, except *G. uzeli* Zimm. which has a little wider range. *Ficus* galls have been reported from Samoa, Tonga, South Australia, Dutch East Indies, Philippines, Formosa, Malay, India, North and South Africa, Italy, Canary Islands, Florida, West Indies, Mexico (Bagnall, 1928) (Priesner, 1939). The inquilinous thrips are very common in the *Ficus* galls and a large number of species has been reported.

Several outstanding galls of the non-leaf-roll type are as follows:

1) *Austrothrips cochinchinensis* Karny produces large elliptical hollow pouch galls in terminal young leaves of *Calycopteris floribunda* Lam. and *Cordia dichotoma* Forst. f. (=*Myxa* Linn.) in India; the size is as large as 2-2.5 inches in diameter (Ramachandra Rao, 1924).

2) *Smerinthothrips heptapleuri* (Karny) produces a mass of pink horn galls, as long as 1.25 inches, on leaves of the various species of *Schefflera* in the Dutch East Indies (Docters van Leeuwen-Reijnvaan, 1926).

3) *Smerinthothrips heptapleuricola* Takahashi produces a mass of greenish, large horn galls on leaves of *Heptapleurum arboricolum* Hay. in Formosa (Takahashi, 1937).

4) *Kladothrips rugosus* Frog., *K. tepperi* (Karny), *K. rodwayi* Hardy and *K. augonsaxxos* Moulton produce large spherical, hollow pouch galls in leaves of the various species of *Acacia* in Australia (Froggatt, 1906) (Karny, 1911) (Hardy, 1916) (Moulton, 1927).

5) *Thaumatothrips froggatti* Karny produces large knob-shaped twig galls, as large as 1.5 inches x 1 inch, on *Casuarina stricta* Aiton in Australia (Karny, 1922).

6) *Onychothrips tepperi* (Uzel) produces small subspherical stem galls on *Acacia aneura* F. Muell. in Australia (Uzel, 1905).

7) *Phrasterothrips conducans* Pr. produces large bud galls on *Myrcia* sp. in Brazil (Costa Lima, 1935).

Part II: PLANT DISEASE TRANSMISSION

Thrips are involved in causing or transmitting four different groups of plant diseases. One group, toxaemias, is caused by toxin injected by the thrips. The other three groups—bacterial, fungous, and virus diseases—are transmitted by thrips. The transmission of the bacterial and fungous diseases, as far as the reported cases are concerned, is of the mechanical type. These pathogens are frequently disseminated by their adhering on the insect body, indicating that their vector relation is not specific. On the other hand, the transmission in the virus diseases is of the biological type and its vector relation is specific. Thrips, as a group, are not commonly vector insects. The plant diseases transmitted by thrips are far less in numbers than those transmitted by other groups of insects.

The first experimental demonstration of insect transmission of a plant disease was reported about 55 years ago, in 1891, by Waite. He concluded that pear blight, a bacterial disease, was transmitted by bees. Then a series of important discoveries followed. The earliest record on thrips in relation to plant disease is that of Whetzel (1904) which stated that thrips injury on onion aids infection of onion blight, a fungous disease. Then Johnson (1911) found that thrips, presumably *Frankliniella tritici* (Fitch), carried rust spores. The first experimentation on vector relation of thrips with virus disease was made by McClintock and Smith (1918), who discovered that cucumber mosaic was not transmitted by *Thrips tabaci* Lind. Then the first positive transmission was reported by Pittman (1927) who was successful in transmitting spotted wilt through *T. tabaci*. The first reference on bacterial disease was delayed until 1927 and 1929 when Caldis and Hansen stated that thrips are probably a vector for the fig spoilage diseases in California and this was followed by Buchanan (1932) on bean bacteriosis transmitted by *Hercinothrips femoralis* (Reuter).

TOXAEMIAS

There are only a few references incriminating thrips as a phytotoxicogenic insect that secretes a toxic substance and injects it into the host plant while feeding. The disease caused by such origin is called toxaemia. Available knowledge on toxaemias related to thrips is still very incomplete. Further observations and experimentations are needed for a thorough understanding of this special host relationship of thrips with the plant life.

Woods (1900) stated that the stigmonose of carnation is caused by the feeding effects of thrips, aphids, and red spider. Leach (1940, p. 124), citing Woods, stated that the carnation stigmonose caused by aphids is a toxaemia, but he did not include thrips as the

causal insect. Apparently thrips do not have any relation to the disease.

Curzi (1932) stated that peach plume in Italy is caused by traumatic and toxic effects of the feeding punctures of thrips. Kratochvil and Farsky (1942) stated that a malformation of young shoots of larch in Bohemia and Moravia is due to a toxin injected in the process of feeding by *Taeniothrips larvicivorus* K. and F. The reviewer is not aware of the details of their data since the original is not available to him. However, this is the first paper clearly claiming that the toxin secreted by thrips caused the pathogenic conditions of the plants. Reference should be made to the resemblance of the symptoms of this toxaemia with the bud gall produced by thrips.

BACTERIAL DISEASES[4]

Only a few bacterial diseases have been known with which thrips are in vector relation. Such vector relation was experimentally demonstrated, completely or partially, with four diseases and was suspected with two diseases. A negative result of transmission test of a disease was also reported. Of all the cases known, it appears that transmission is of the mechanical type. The pathogen could not be isolated from the internal organs in two cases. Although an association of infection at the sites of feeding injuries was reported in one case, no clear statement was made as to whether actual inoculation or aiding for ingression is provided by thrips. However, it is presumable that inoculation, in the strict sense, may not always take place. On the contrary, aiding ingression, that is the ingression of the pathogen into the tissues through the feeding injuries, may more commonly occur. It is quite probable that thrips may aid dissemination only in certain cases, and in these cases the pathogen may ingress irrespective of any presence of feeding injuries.

In a greenhouse experiment, bean bacteriosis (*Pseudomonas medicaginis* var. *phaseolicola* [Burkh.] Stapp and Kotte) was conclusively demonstrated to be transmissible by *Hercinothrips femoralis* (Reuter) (Buchanan, 1932). The lesions were always associated with the feeding injuries. The observations were not made on the details of transmission mechanism but Leach (1940, p. 206) stated that it appears to be mechanical. Fire blight (*Erwinia amylovora* [Burrill] Winslow *et al.*) of the stone fruit flowers is an historic case of plant disease transmitted by insects (Waite, 1891). Thrips are now considered to be one of the vectors but conclusive experimental demonstration is still lacking. Waite (1894) studied the flower-visiting insects of pears in connection with a search for the vectors but he failed to mention if any thrips were observed. Treherne (1923), 30 years after Waite, stated that *Frankliniella*

[4] The names of the bacteria are after Weiss and Wood (1943).

tritici (Fitch) has been incriminated as a vector in Canada and Oregon. Thomas and Ark (1934) observed that thrips carry the organism on the body. Bailey (1935) published the supplementary data supporting Thomas and Ark's conclusion; he also stated that the species of thrips involved in one of the tests Thomas and Ark made were *Frankliniella moultoni* Hood and *Taeniothrips inconsequens* (Uzel). Bailey (1935) urged further experimental work on transmission, but evidently nothing had been done by 1944 as Bailey (1944) stated that such tests with *T. inconsequens* were still needed.

The fig spoilage diseases in California are caused by a complex of bacteria, yeasts, and fungi; various species of insects, including thrips, are known to be vectors. The work by Caldis (1927), Hansen (1929), Smith and Hansen (1931), Hansen and Davey (1932), and Davey and Smith (1933) collectively demonstrated that the causal organisms are carried and inoculated by thrips. The several tests made were not conclusive but indications were clear that thrips are of some importance in regard to natural spreading of the diseases. Several species of thrips were involved, and the corrected identification of them given by Bailey (1935) are *Thrips tabaci* Lind., *Frankliniella tritici* (Fitch), *F. moultoni* Hood, *F. occidentalis* (Perg.), *Hercothrips fasciatus* (Perg.), and *Leptothrips mali* (Fitch).

Poos and Elliott (1936) and Elliott and Poos (1940) reported that bacterial wilt of corn (*Bacterium stewarti* E. F. Sm.) was not transmitted by *Hercinothrips femoralis* (Reuter) from corn to corn. *Aeolothrips fasciatus* (Linn.), *Anaphothrips obscurus* (Müll.), and *Frankliniella williamsi* Hood from the infected fields were not carrying the pathogen internally, but *A. obscurus* was carrying it externally. No further transmission test with the last species was made. Ark (1944) experimentally demonstrated that the bacterial canker of tomato (*Corynebacterium michiganensis* [E. F. Sm.] Jensen) was not transmitted by *Thrips tabaci* Lind., and also stated that the pathogen was not isolated from the mouth parts or the internal organs of the thrips. Semenov (1930) stated, without experimental demonstration, that *T. tabaci* was probably responsible for the transmission of a bacteriosis of tobacco (*Bacterium tabaci* [Wolf and Foster] Stapp) in Ukraine.

Pussard-Radulesco (1931) cited a bacteriosis of carnation (*Bacterium dianthi* Arthur and Bolley) transmitted by thrips without giving full reference. Evidently Pussard-Radulesco made an incorrect interpretation of Woods' work (1900), to which he apparently referred. Woods stated that *Bacterium dianthi,* claimed by Arthur and Bolley (1896) to be the pathogen for a carnation disease, is a secondary organism, and the true cause of the disorder, which was renamed by Woods as stigmonose, is the feeding effects of thrips, aphids, and mites.

FUNGOUS DISEASES

Thrips-transmissible fungous diseases are also few in numbers so far as recorded. Four diseases have been known with complete experimental demonstrations, three with incomplete experimental demonstrations, and several others with observational remarks only. The type of vector relation existing in the thrips-transmissible fungous diseases is essentially similar to that of the bacterial disease group. A case of aiding ingression or inoculation played by thrips was reported, but the common occurrence appears to be the aiding of dissemination only. Certain types of fungous spores are readily carried by thrips as commonly as the pollens, and many more fungous diseases than the few cases already recorded might be disseminated by thrips under natural conditions. However, such type of spore would also be wind-borne or rain-borne and so the role played by thrips may be generally insignificant. The above also appears to be true in the cases of bacterial disease.

Howard (1923) demonstrated that *Pestalozzia* sp. on camphor trees was experimentally transmitted by *Liothrips floridensis* (Watson). The spores were carried on the body of the thrips and infection occurred only at the sites of the feeding injuries. Apparently aiding ingression or inoculation was provided by the thrips in addition to dissemination of the pathogen. A rust (*Puccinia graminis* Pers.) was experimentally transmitted by *Hercinothrips femoralis* (Reuter) which previously made contact with urediniospores in the cultures or on the infected plants (Granovsky and Levine, 1932). Many years before the above work was reported, Johnson (1911) observed that rust spores (*Puccinia graminis tritici* Eriks. and Henn. and *P. rubigo-vera tritici* [Eriks.] Carleton) were commonly carried by thrips (presumably *Frankliniella tritici* [Fitch]) on its body, and suspected the thrips to be a disseminator under natural conditions.

Weiss and Smith (1940) and Smith and Weiss (1942) reported an experimental transmission of azalea flower spot (*Ovulinia azaleae* Weiss) by *Heterothrips azaleae* Hood. The spores were carried by the insect body but the infection occurred irrespective of the insect abrasions on the flowers; apparently only dissemination was provided by the vector. A transmission test with *Frankliniella tritici* (Fitch) was negative. The causal organisms, including fungi, yeasts, and bacteria, of the fig spoilage diseases of California were transmitted by several species of thrips. The details of this topic have been discussed under the bacterial diseases.

Intimate association of thrips with pathogenic fungi was observed in three cases. These species may quite certainly be capable of disseminating the spores, although no transmission test was made in any of the cases. Ramakrishna Ayyar (1928) observed in India that *Anaphothrips fungivora* Ramakrishna was feeding upon rusts

on wheat plants. Bailey (1935) observed *Thrips tabaci* Lind. frequently carrying spores of black mold (*Aspergillus niger* van Tieg.) on bulb onions. Yarwood (1943) observed that *T. tabaci* was feeding upon several species of powdery mildews on vine, rose, strawberry, cantaloupe, clover, and *Oenothera* sp. He also observed in an experimental test that thrips thrived better feeding on the mildewed leaves than feeding on the normal leaves.

Observational notes were made on the following five cases. Whetzel (1904) stated that the infection of *Peronospora schleideniana* de Bary on onion was accentuated where thrips injuries were inflicted. Corbett (1931) suspected a thrips (? *Heliothrips haemorrhoidalis* [Bouché]) of transmitting a pathogen affecting coffee seed in Malay. Laumont and Murat (1934) also suspected a thrips to be a vector of the causal agents, a complex of bacteria and fungi, of the Moucheture disease of grain in Algeria. Russo (1936) stated that *Thrips tabaci* Lind. appeared to facilitate the diffusion of a leaf spot disease of onion in Santo Domingo. Harris (1944) reported an association of *T. tabaci* and a fungus (*Cladosporium* sp.) in pyrethrum flowers in Tanganyika, suspecting a vector relation.

Pussard-Radulesco (1931) cited an *Alternaria* disease on tobacco transmitted by thrips, without giving full reference. The reviewer has not been able to locate the original reference.

VIRUS DISEASES

A considerable knowledge of thrips in their vector relationships with the viruses has been accumulated in recent years. It is far more complete than with the bacterial and fungous diseases. The vector relationships of thrips with the viruses are biological, and are more intimate, specific, or obligatory than those with other groups of pathogens which are mechanically transmitted. Here, thrips acquire the virus internally from the plant tissues infected, process the virus biologically within the body, and inoculate the virus into the plant tissues where the virus can establish itself. Furthermore, the dissemination and inoculation of the viruses are entirely dependent on the insect vectors under field conditions except for a few particular viruses which depend on other means.

The insect-transmissible viruses are divided on the basis of the vector relationships into two groups: persistent and non-persistent types (Watson and Roberts, 1939). The persistent type is characterized by a long retention of the virus by the vector and by a latent period in the vector's body. Only a few viruses belong to this group. The non-persistent type is characterized by a short retention of the virus and the absence of the latent period. Many viruses belong to this type.

The viruses are also divided on the basis of their relation to plant tissues into three groups: phloem, phloem-parenchyma, and paren-

chyma types (Bennett, 1940). The persistent viruses in most cases are present only in the phloem tissues. Acquisition or inoculation can be made only by the vectors of the phloem feeder type which have a long proboscis that extends deeply into the phloem tissues. This type of virus is not sap-transmissible. The non-persistent viruses in most cases occur in both phloem and parenchyma tissues and acquisition or inoculation can be made through the parenchyma tissues by the vectors which feed chiefly or exclusively on the parenchyma tissues. This type of virus is always sap-transmissible.

The mouth of thrips, both larva and adult, is adapted only to gashing the epidermal and other nearby cells and sucking out the cell content of the parenchyma tissues. The vascular bundle tissues may not be ordinarily reached by the thrips, but such contact may occur under certain conditions. In view of this, thrips could only be vectors for the parenchyma-phloem or parenchyma type of viruses.

Thrips have already been tested for their vector relations with many viruses but only one virus, that of spotted wilt, has been authentically demonstrated to be transmissible by thrips. There is another case, but presentation of the evidence was incomplete. This review includes not only positive cases of transmission but also negative cases and those without experimental proof. For synonyms or affinities in strain relation of viruses, the latest reference by Wiltshire (1946) was consulted principally.

The negative cases of transmission

Cucumber mosaic is the first virus disease with which thrips were tested in regard to the vector relation. McClintock and Smith (1918) noticed *Thrips tabaci* Lind. abundant on diseased spinach plants, the disease being called spinach blight. The result of their transmission test was negative. Doolittle (1920) again demonstrated that *T. tabaci* is not a vector of the virus. Sakimura (1940) could not transmit the commelina mosaic virus, a strain of the cucumber mosaic virus, through *T. tabaci*. Several species of aphids and cucumber beetles are known to be the vectors of the cucumber mosaic virus. Whetzel (1923) suspected *Physothrips eucharii* Morgan (ms.),[5] which was abundant on the diseased plants, to be a possible vector of a mosaic on *Eucharis* lily in Bermuda, probably caused by the lily mosaic virus, which is a strain of the cucumber mosaic virus. Ogilvie (1928a) observed in Bermuda thrips on *Hippeastrum* lily affected with a mosaic, probably caused by the same virus aforementioned; and *Frankliniella insularis* Frank. on lilies affected with the yellow flat virus, a synonym for the lily rosette virus which is distinct from the lily mosaic virus. However, Ogilvie (1928b) and Ogilvie and Guterman (1929) later failed to

[5] This name was proposed by A. C. Morgan who examined the specimens (Rept. Bd. Dept. Agr. Bermuda 1922: 30, 1923). However, this probably is a manuscript name, since no described species with this name has been recorded.

mention any species of thrips among a list of insects tested for vectors of these two viruses. The latter virus is transmissible by an aphid.

An extensive search was made in the early years for the vector of the sugar cane mosaic virus. Before the authentic discovery was made of the vector relation with *Aphis maidis* Fitch (Brandes, 1920), Smyth (1919) in Puerto Rico made a survey of sugar cane insects and found *Frankliniella* sp. and *Adraneothrips tibialis* (Hood).[6] His small preliminary transmission test with both species suggested a negative indication. Smyth's work was done one year after that of McClintock and Smith (1918), and is the second contribution made in the field of thrips transmission of the viruses. Wolcott (1921) mentioned thrips as a possible vector in Puerto Rico. Bruner (1922) tested a species of thrips, probably *Hercothrips insularis* Hood,[7] in Cuba, but the result was negative. Puttemans (1926) observed *Thrips minutus* var. *puttemansi* Costa Lima[8] abundant on diseased canes in Brazil and suspected its vector relation. Loftin and Christenson (1932) demonstrated that an unidentified thrips did not transmit the virus in Cuba. Ingram and Summers (1936) stated that *Haplothrips graminis* Hood gave negative results in a transmission test conducted in Louisiana. Ingram, Haley and Charpentier (1939) still had the opinion that thrips are a possible vector in Louisiana. The known vectors of the virus are several species of aphids.

Schultz and Folsom (1925) suspected thrips to be a possible vector of the potato mosaic virus complex, based upon their observations of its presence on potato plants in a greenhouse. In the same year, Iddings (1925) reported a negative result of a test with thrips to transmit a potato mosaic which is, he stated, similar to one of the

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[6] For the name of this species, see also Hood, Psyche **32**: 54, 1925.

[7] For the specific name, see Morgan, Proc. Ent. Soc. Wash. **31**: 9, 1929; Hood, Jour. Ent. Soc. S. Africa **3**: 37, 1940; and Bruner, *et al.*, Esta. Exp. Agro. Cuba Bol. **63**: 158, 1945.

[8] *Thrips minutus* van Dev. was briefly described from specimens collected on sugar canes from Java (van Deventer, Handboek Suik.-Cult. Reitsuik.-Fabr. Java **2**: 281, 1906). Its original description is insufficient to recognize the species and no collection of this species has been recorded from any other part of the world. Priesner (Nat. Tijd. Neder.-Indies **94**: 290, 1934) stated that probably *Thrips saccharoni* Moulton (Proc. Haw. Ent. Soc. **7**: 111, 1928), which was described from Hawaii, is a synonym for *T. minutus*. *T. saccharoni* has been collected from New Guinea, New Britain, and Loochoo in the Pacific region. *Thrips minutus* var. *puttemansi* Costa Lima was described from Brazil (Costa Lima, Chacaras Quintaes **34**: 32, 1926). Moulton (Rev. de Ent. **3**: 132, 1933) collected *T. saccharoni* in Sao Paulo, Brazil, but not *T. minutus puttemansi*. He mentioned both species in a treatise on South American thrips (*ibid.*) without giving any statement on the validity of *T. minutus puttemansi*. Because of the fact that some sugar cane insects have been distributed world-wide through the transportation of seedling material, the reviewer is of the opinion that the Javanese, Hawaiian, and Brazilian species may possibly be the same species. In Hawaii, *T. saccharoni* has never been suspected to be the vector of the disease, as Kunkel (1922, 1924) and Hadden (1928) did not specifically mention this species. Present-day workers in Hawaii have seen no field indication for such suspicion.

A comparison between the type material of *T. minutus* var. *puttemansi* and *T. saccharoni* was made after this paper had been written. They are identical. A cotype of the former species was made available through the courtesy of Dr. Costa Lima, Instituto Oswaldo Cruz, Rio de Janeiro, Brazil. The material of the latter species compared was a paratype; a series of additional specimens collected on Hawaii and Loochoo was also consulted.

types Schultz and Folsom (*ibid.*) described. Iddings (1925) also stated that the potato leaf roll virus was not transmitted by thrips in a test. Cleveland (1931) reported a negative result with *Thrips tabaci* Lind. in a preliminary transmission test. Again, Cottier (1931) also had a negative result with *T. tabaci* in New Zealand. This virus is transmissible by several species of aphids. Kunkel (1926) stated that *T. tabaci* was not able to transmit the aster yellows virus which is transmissible by a leafhopper.

Böning (1927a) suspected a species of thrips, possibly *Thrips tabaci* Lind., abundant on the affected beets, to be a possible vector of the beet mosaic virus. The virus is transmissible by several species of aphids. Böning (1927b) also conducted a preliminary transmission test of the bean mosaic virus with *Thrips flavus* Schrank which was abundant on the diseased plants. A few positive infections were observed, but he considered the results to be inconclusive. Fajardo (1928, 1930) stated that the bean mosaic virus was not transmitted by *Hercothrips fasciatus* (Perg.). The virus is transmissible by several species of aphids.

Jarrett (1930) demonstrated that *Thrips tabaci* Lind. is not a vector of the tobacco mosaic virus and tomato streak virus; the latter is a strain of the former. Adults as well as larvae were tested. Cleveland (1931) reported that few out of many test plants were infected in a transmission test with *T. tabaci*. The virus was called the tomato mosaic virus. He concluded that *T. tabaci* is probably capable of transmitting the virus to a limited degree. His results are contrary to the conclusive data presented by Jarrett (*ibid.*) and also have not been confirmed since. Presumably, some experimental errors must have been involved in Cleveland's test. This virus is known to be non-insect-borne.

Jarrett (1930) also demonstrated that *Thrips tabaci* Lind. is not the vector of the potato virus X, which has been known in earlier references as potato mosaic. Hamilton (1932) again demonstrated that the virus, which was called *Hyoscyamus* virus IV, was not transmitted by *T. tabaci*. Bawden (1934), studying the potato virus D, a strain of the potato virus X, found that the virus was not transmitted by *T. tabaci*. The potato virus X is known to be non-insect-borne. A presentation of inconclusive data was made by Smith (1937, p. 343) who stated that he has had or appeared to have five positive infections out of 100 tests with various species of flower-infesting thrips. Cockerham (1937), however, presented circumstantial evidence not supporting Smith's data.

Thrips were suspected to be a possible vector for the sandal spike virus in India as early as 1931 (Chatterjee and Dover, 1931). Dover and Appanna (1934) reported a negative result from a preliminary mass transmission test with thrips and other allied insects. Chatterjee (1940) and Rangaswami Iyenger and Griffith (1940)

both presented negative results from outdoor transmission tests with many specimens of unidentified thrips. The true vector has not been conclusively determined yet. Hamilton (1932) recorded negative data from transmission tests with *Thrips tabaci* Lind. of the potato virus Y, which was called *Hyoscyamus* virus II, and of the henbane mosaic virus, which was called *Hyoscyamus* virus III. Both viruses are transmissible by the same species of aphid. Hargreaves (1932) stated that a mosaic virus of peanuts, probably the groundnut rosette virus, in Sierra Leone was not transmitted by thrips (unidentified species). The rosette virus is transmissible by an aphid. Hodson (1932) and Hall (1932) suspected *T. tabaci* to be a possible vector of the narcissus mosaic virus. However, the recent experimental demonstrations by Blanton (1939) and Blanton and Haasis (1942) showed that *T. tabaci* and *Frankliniella fusca* (Hinds) did not transmit the virus on a long series of test plants. The virus is transmissible by many species of aphids.

Thrips were once suspected to be a possible vector of the fig mosaic virus in California (Condit and Horne, 1933). No insect vector has been discovered yet. Weimer (1934) stated that the alfalfa mosaic virus was not transmitted by *Frankliniella occidentalis* (Perg.). The vector of the virus is an aphid. The potato yellow dwarf virus was not transmitted by *Thrips tabaci* Lind. in a test conducted by Koch (1934). This virus is transmissible by two species of leafhoppers. Hartzell (1935) demonstrated that the peach yellows virus, of which a leafhopper is the vector, was not transmitted by either the adults or the larvae of *T. tabaci* and *Hercinothrips femoralis* (Reuter). Smith and Bald (1935) also demonstrated with the larval stage that the tobacco necrosis virus was not transmitted by *T. tabaci.* This is one of the non-insect-borne viruses. Chamberlain (1935) reported that *T. tabaci* did not transmit the pea mosaic virus, which was called sore-shin of blue lupines. The virus is transmissible by several species of aphids.

Johnson (1936) stated that the tobacco streak virus was not transmitted by *Thrips tabaci* Lind. and an undetermined species of greenhouse thrips. The vector of this virus has not been discovered. The lucerne witches' broom virus was not transmitted by thrips in a preliminary test conducted by Edwards (1936). Menzies (1946) reported a negative result for the transmission test of the same virus with many sucking insects common on alfalfa, probably including some thrips. This virus is transmissible by a leafhopper. The tomato big bud virus, which was called Stolbur disease, was once considered by Koratshevsky (1936) to be probably transmissible by *Thrips* sp. in Russia. However, Thomas and Krishnaswami (1939) reported the virus, which was called eggplant little leaf, was not transmitted by an undetermined species of thrips, and also Hill (1943) recently

stated that *T. tabaci* did not transmit the virus. This virus is transmissible by a leafhopper.

Costa (1937) stated that an unidentified species of thrips present on cotton was suspected of being a possible vector of a cotton mosaic virus in Brazil, distinct from the cotton leaf curl virus. The alfalfa dwarf virus was not transmitted by *Frankliniella occidentalis* (Perg.) in a test conducted by Weimer (1937) and again by thrips in another test conducted by Hewitt *et al.* (1946). This virus is transmissible by several species of leafhoppers. Bennett and Wallace (1938) reported a negative result for *Hercinothrips femoralis* (Reuter) in a transmission test of the beet curly top virus which is transmissible by a leafhopper. Zaumeyer (1938) stated that the pea streak virus in a preliminary test was not transmitted by *Thrips tabaci* Lind. Chamberlain (1939) also stated that *T. tabaci* did not transmit the same virus; the larval stage was used in the test. This virus is transmissible by an aphid. Pea streak mentioned here is distinct from the one known under the same name but caused by the spotted wilt virus and freely transmitted by *T. tabaci* (Linford, 1931b; Whipple, 1936). Goidanich (1938) reported a virus disease of sugar sorghum in Italy without giving its identity. He discussed a possible vector relation of *Limothrips schmutzi* Pr. and *Haplothrips aculeatus* F. which were abundant on the diseased plants. Noble and Noble (1939) stated that five species of thrips, including *Hercinothrips bicinctus* (Bagn.) did not transmit the passion fruit woodiness virus which is transmissible by several species of aphids.

No insect vector has been determined for the *Pelargonium* leaf curl virus, but Pirone (1940) stated that circumstantial evidence suggested that a species of thrips may be one of the possible vectors. Brierley and Smith (1940) and Smith (1940) stated that none of the insects tested, including *Frankliniella tritici* (Fitch), proved to be the vector for the rose mosaic and rose streak viruses. Tate (1940) experimentally demonstrated that *Thrips tabaci* Lind. is not a vector for the onion yellow dwarf virus which is freely transmissible by many species of aphids. Holdaway and Look (1940) stated that none of the insects tested, including *T. tabaci*, transmitted a papaya mosaic in Hawaii. This disease is distinct from papaya ringspot also recently discovered in Hawaii; the latter is transmissible by an aphid (Jensen, 1946). Morrison (1940) was of the opinion that *T. tabaci* and *Frankliniella moultoni* Hood which were abundant on the diseased plants may be possible vectors of the virus-like symptoms observed on hops in the Willamette Valley.

Zazhurilo and Sitnikova (1941) demonstrated that the winter wheat mosaic virus in Russia which is transmissible by a leafhopper was not transmitted by *Haplothrips tritici* Kurdjumov. *Selenothrips rubrocinctus* (Giard) was tested with a negative result for trans-

mitting the cacao swollen shoot virus in Gold Coast (Posnette, 1941). The vector has not been conclusively determined yet. *Heliothrips haemorrhoidalis* (Bouché) and an unidentified thrips found on the infected plants were listed among possible vectors of the tea phloem necrosis virus; the true vector has not been determined (King, 1941). Cardamon mosaic of India was once suspected to be transmissible by *Taeniothrips cardamomi* Ramakrishna (Anonymous, 1941), but Uppal, Verma and Capoor (1945) reported that the disease was not transmitted by *T. cardamomi* but by an aphid. Costa (1941) suspected thrips to be a possible vector for a peanut ringspot virus in Brazil which, he stated, resembles somewhat the groundnut rosette and spotted wilt viruses.

A tomato ringspot virus which symptomatologically resembles the spotted wilt virus was not transmitted by *Thrips tabaci* Lind.; no other insect has been tested for vector yet (Samson and Imle, 1942). Jones (1942) reported that an eggplant yellows, which has not been identified with any other known virus, was not transmitted by all the insects tested, including *T. tabaci.* A zonate chlorosis of citrus in Brazil was suggested to be of virus origin and thrips were suspected to be a possible vector (Reiniger 1942). Smith (1943) demonstrated that the belladonna mosaic virus is not transmissible by *T. tabaci.* This virus is sap-transmissible but has been thought to be non-insect-borne. Jones (1944) stated that the cineraria mosaic virus which is transmissible by an aphid was not transmitted by *T. tabaci.* Jones (1945) also stated that the carnation mosaic and carnation streak viruses were not transmitted by *T. tabaci.*. The vector for the former virus has not been determined yet but the latter virus is transmissible by an aphid. Orlando and Silberschmidt (1945) stated that two species of thrips are not vectors of infectious chlorosis of *Sida* spp. in Brazil, which is probably caused by the abutilon variegation virus. The *Sida* virus is transmissible by an aleyrodid. One of the thrips tested was *Sericothrips sidae* Crawford,[9] but the identity of the second species has not been published yet.

The foregoing references on the negative data from the transmission experiments are summarized in Table 1. Thrips were mentioned in connection with 48 viruses. Thirty-nine viruses out of the 48 were experimentally demonstrated for their negative transmission through the species of thrips tested, and 9 viruses were suspected for their possible vector relation but remained without any experimental proof. However, the number of viruses tested is only about one-fifth of all the known viruses and many more remain to be tested. Most of the principal viruses are more or less included among those already tested.

[9] For the name of the species, see also Crawford, Proc. Ent. Soc. Wash. **46**: 200, 1944.

Table 1. Summary of Negative Data from Transmission Experiments of Viruses by Thrips

Virus	Thrips	Reference
Cucumber mosaic	*Thrips tabaci* Lind.	McClintock & Smith (1918); Doolittle (1920); Sakimura (1940)*.
Sugar cane mosaic	*Frankliniella* sp. *Adraneothrips tibialis* (Hood) ? *Hercothrips insularis* Hood A thrips *Haplothrips graminis* Hood	Smyth (1919); Bruner (1922); Loftin & Christenson (1932); Ingram & Summers (1936).
Potato leaf roll	Thrips *Thrips tabaci* Lind.	Iddings (1925); Cleveland (1931); Cottier (1931).
Aster yellows	*Thrips tabaci* Lind.	Kunkel (1926).
Beet mosaic	? *Thrips tabaci* Lind.	Böning (1927a).
Bean mosaic	*Thrips flavus* Schrank *Hercothrips fasciatus* (Perg.)	Böning (1927b); Fajardo (1928, 1930).
Tobacco mosaic	*Thrips tabaci* Lind.	Jarrett (1930); Cleveland (1931)*.
Potato virus X	*Thrips tabaci* Lind.	Jarrett (1930); Hamilton (1932); Bawden (1934)*.
Sandal spike	Thrips	Dover & Appanna (1934); Chatterjee (1940); Rangaswami Iyenger & Griffith (1940).
Potato virus Y	*Thrips tabaci* Lind.	Hamilton (1932).
Henbane mosaic	*Thrips tabaci* Lind.	Hamilton (1932).
Groundnut rosette	A thrips	Hargreaves (1932).
Narcissus mosaic	*Thrips tabaci* Lind. *Frankliniella fusca* (Hinds)	Blanton (1939); Blanton & Haasis (1942).
Alfalfa mosaic	*Frankliniella occidentalis* (Perg.)	Weimer (1934).
Potato yellow dwarf	*Thrips tabaci* Lind.	Koch (1934).
Peach yellows	*Thrips tabaci* Lind. *Hercinothrips femoralis* (Reuter)	Hartzell (1935).
Tobacco necrosis	*Thrips tabaci* Lind.	Smith & Bald (1935).
Pea mosaic	*Thrips tabaci* Lind.	Chamberlain (1935).
Tobacco streak	*Thrips tabaci* Lind. A greenhouse thrips	Johnson (1936).
Lucerne witches' broom	Thrips	Edwards (1936).
Tomato big bud	A thrips *Thrips tabaci* Lind.	Thomas & Krishnaswami (1939); Hill (1943).

Table 1—Continued

Virus	Thrips	Reference
Alfalfa dwarf	*Frankliniella occidentalis* (Perg.) Thrips	Weimer (1937) ; Hewitt *et al.* (1946).
Beet curly top	*Hercinothrips femoralis* (Reuter)	Bennett & Wallace (1938).
Pea streak	*Thrips tabaci* Lind.	Zaumeyer (1938) ; Chamberlain (1939).
Passion fruit woodiness	*Hercinothrips bicinctus* (Bagn.) Four other species	Noble & Noble (1939).
Rose streak	*Frankliniella tritici* (Fitch)	Brierley & Smith (1940) ; Smith (1940).
Rose mosaic	*Frankliniella tritici* (Fitch)	Brierley & Smith (1940) ; Smith (1940).
Onion yellow dwarf	*Thrips tabaci* Lind.	Tate (1940).
Papaya mosaic	*Thrips tabaci* Lind.	Holdaway & Look (1940).
Winter wheat mosaic	*Haplothrips tritici* Kurdjumov	Zazhurilo & Sitnikova (1941).
Cacao swollen shoot	*Selenothrips rubrocinctus* (Giard)	Posnette (1941).
Cardamon mosaic	*Taeniothrips cardamomi* Ramakrishna	Uppal, Verma, & Capoor (1945).
Tomato ringspot	*Thrips tabaci* Lind.	Samson & Imle (1942).
Eggplant yellows	*Thrips tabaci* Lind.	Jones (1942).
Belladonna mosaic	*Thrips tabaci* Lind.	Smith (1943).
Cineraria mosaic	*Thrips tabaci* Lind.	Jones (1944).
Carnation streak	*Thrips tabaci* Lind.	Jones (1945).
Carnation mosaic	*Thrips tabaci* Lind.	Jones (1945).
Sida infectious chlorosis	*Sericothrips sidae* Crawford A thrips	Orlando & Silberschmidt (1945).

* References dealing with separate strains are also included.

There is an obvious shortcoming in evaluating such type of data on the negative results of transmission tests. Many of the tests reported were parts of exploratory work for search of the vectors which were conducted before the discovery of the true vectors. Naturally, design of these tests were generally not very elaborate and adequate repetitions were not made. Generally speaking, any experimental demonstration for proving the negative relationship requires a reasonable number of repetitions of test to provide sufficient evidence for the final conclusion. This general principle should be true in the present cases and the indications seen in some of the tests which are apparently of a preliminary nature are technically

not conclusive. However, some of the transmission tests, although few in numbers, are apparently conclusive because of design of the tests and number of the replicates tested. Another type of conclusive demonstration is the case where the same species of thrips is tested with a virus more than once under different circumstances. Regardless of whether the experiments were conclusive or not, almost all of the negative results are convincing because of supporting circumstantial evidence.

Negative acquisition of the virus by the adult stage of thrips was well demonstrated in the case of the spotted wilt virus. It is entirely a matter of speculation to foresee whether or not this special feature in the mode of transmission may be commonly true with other potential thrips-transmissible viruses. If this be true, some of the data may not be valid because the tests made might not have included the larval insects at the time of acquisition. In fact, clear statements were rarely made in the references on the stages of insect used in the test. However, the larval stage was used in some of the tests, as it was so stated or the procedure of the tests so suggested.

The most commonly tested species is *Thrips tabaci* Lind., because of its common occurrence in greenhouses where tests were made, and also because of the earlier discovery of its positive vector relationship with the spotted wilt virus. Twenty-four other viruses have been tested for their transmission through this species and none was transmitted. *Frankliniella occidentalis* (Perg.), another known vector of the spotted wilt virus, was tested on two different viruses. The other species tested on more than one virus are *Frankliniella tritici* (Fitch) and *Hercinothrips femoralis* (Reuter). The species tested on one virus only are *Hercothrips fasciatus* (Perg.), *H. insularis* Hood, *Hercinothrips bicinctus* (Bagn.), *Selenothrips rubrocinctus* (Giard), *Sericothrips sidae* Crawford, *Frankliniella fusca* (Hinds), *Taeniothrips cardamomi* Ramakrishna, *Thrips flavus* Schrank, *Adraneothrips tibialis* (Hood), *Haplothrips graminis* Hood, and *H. tritici* Kurdjumov. More than 13 species tested remained undetermined.

Among 39 viruses tested, ten or more belong to the persistent type. The viruses of this type are usually not available in the parenchyma tissues, on which the thrips feed. Any virus of this type may not be thrips-transmissible. About 25 or less of the viruses tested, at least most of them, belong to the non-persistent type. The viruses of this type are usually available in the parenchyma tissues and may be ingested by thrips. In these cases, the negative transmissions are probably due to some internal barrier or a negative specificity within the insects. A few of the non-persistent type viruses are transmitted with extreme ease by many vectors belonging to a single order or even to different orders of insects. Some workers consider that this group is transmitted mechanically by insects, and others disagree with this concept. The cucumber mosaic virus and the

onion yellow dwarf virus are known to belong to this group and yet the thrips tested failed to transmit them. Four viruses tested are known to belong to the non-insect-borne type.

The vector relation of insects with the viruses are specific. The specificity, however, varies in degree with the different viruses, but at least group specificity always occurs except in the few cases aforementioned. No virus is known to have co-vectors belonging to different orders of insects. This generalized fact suggests that the thrips are unlikely to be additional vectors of the viruses known to be transmissible by insects other than thrips. In other words, all the known insect-transmissible viruses except the spotted wilt virus may not be thrips-transmissible. The possibility of finding additional thrips-transmissible viruses appears to be small. However, the aforementioned generalized fact suggests that the potential ones will be those of the parenchyma or sap-transmissible type but known to be not transmissible by any other group of insects.

Thrips injuries once confused as of virus origin

There are several cases of pathological disorder once attributed to virus origin but since discovered to be caused by thrips injuries. Uppal (1929, 1930) reported a mosaic disease of chillies in Bombay Presidency which he then thought was experimentally transmitted by *Thrips* sp. In his recent correspondence with the reviewer, he stated that the disease has been found to be caused by the feeding of thrips and that a paper on the subject is expected shortly. Park and Fernando (1938) and Johnpulle (1939) stated that chilli leaf curl in Ceylon, probably allied with chilli mosaic (*ibid.*), is not an insect-borne virus disease but direct injuries of thrips. Subsequently, *Scirtothrips dorsalis* Hood was found to be responsible for the disorder (Anonymous, 1942). Curzi (1932) concluded that peach plume in Italy is not of virus origin but is caused by the feedings of thrips. Kratochvil and Farsky (1942) also concluded that a malformation of young shoots of larch is not a virus disease but a toxaemia caused by *Taeniothrips larvicivorus* K. & F.

The positive cases of transmission

In contrast to a long series of references reviewed on the negative cases of transmission there are only two viruses with the positive vector relationship. One is the spotted wilt virus which has been extensively tested, and the details will be discussed in the next chapter. The other is a pistachio rosette in USSR which was stated to be transmissible by *Liothrips pistaciae* Kreutzberg. In 1940, Kreutzberg published a brief preliminary note on a new virus disease of pistachio trees found in Tulkoman, Uzbekistan, and Tadjikistan. He presented a brief summary on the result of his transmission test but never mentioned any description or procedure of the test and the original data. He stated simply, "*L. pistaciae* was tested and found

able to transmit the disease." He also stated that the disease was transmitted by seeds and occasionally by grafting, but not by pollen and juice inoculation. There appears to be a slight discrepancy in these characteristics mentioned from the general type of thrips-transmissible virus. The reviewer is not aware of any other paper published on the same subject. Because of the incomplete presentation of the data, the reviewer will ignore this reference in the general discussion of the subject. There is another case of positive transmission of *Lycopersicum* virus 7. This virus, however, is suspected to be a strain of the spotted wilt virus and will be discussed in the next chapter.

SPOTTED WILT

The vectors

Spotted wilt is the only plant virus disease authentically demonstrated to be transmissible by thrips. The disease was recorded as early as 1906 by Lounsbury in the Union of South Africa and in 1919 by Brittlebank in Australia. However, critical studies of the disease particularly in respect to its insect vector were not started until the late 1920s, when three groups of workers initiated their studies independently in widely separated districts. The Australian workers started their project in 1926 (Dickson, 1929), the Hawaiian workers in 1927 (Illingworth, 1931), and the South African workers in 1929 (Moore, 1933).

Pittman (1927) from Australia first reported a successful transmission by *Thrips tabaci* Lind. He tested several insects found on diseased tomato plants but transmission was made only by thrips, probably *T. tabaci* but other species might also have been mixed. This is the first reference of thrips transmission of plant virus disease. Further results of tests conducted in Australia were reported by Samuel, Bald and Pittman (1930) who stated that the virus was freely transmitted by *Frankliniella insularis* Frank. Again, Samuel and Bald (1931) reported transmissions by *T. tabaci* and *F. insularis* confirming the previous results. Further work on *F. insularis* was reported by Bald and Samuel (1931). The results of the Hawaiian workers were first published in 1931. Linford (1931a) briefly reported the vector relationship of *T. tabaci* with the yellow spot virus, which is now known to be identical with the spotted wilt virus with perhaps a different strain composition. Illingworth (1931) also presented data on his exploratory work. The discovery by the Hawaiian workers was made independently of the Australian workers. Discovery of egg punctures of thrips near the local lesions on pineapple plants led to the effort to test *T. tabaci* which was common on a weed, *Emilia sonchifolia* (L.) DC., that was infected by the virus, unidentified at that time.

Smith (1931b) who identified the spotted wilt virus at Cardiff, Wales, demonstrated that *Thrips tabaci* Lind. is the vector there.

A preliminary work on the vector of this virus was also reported in his previous paper (Smith, 1931a). It is interesting to note that Samuel and Bald (1931), Linford (1931a), and Smith (1931b), all reporting positive transmissions by *T. tabaci,* were published at about the same time from March to September of the same year. Both Linford (1932) and Smith (1932) gave the full reports on the data which were briefly reported previously (Linford, 1931a) (Smith, 1931b). Moore in South Africa published a brief note in 1932 and a full report in 1933 (Moore, 1932; 1933). She stated that *Frankliniella* sp. transmitted the Kromnek virus which is now accepted as identical with, or as a strain of, the spotted wilt virus. The specific name of the vector was later given as *Frankliniella schultzei* (Tryb.) (Moore and Anderssen, 1939). Gardner and Whipple (1934) and Gardner, Tompkins, and Whipple (1935), who identified the spotted wilt virus in California, stated that the virus was transmitted by *T. tabaci* and *Frankliniella* sp. Bailey (1935), who examined the specimens tested by the above workers, identified *Frankliniella moultoni* Hood; but his species concept was such that another allied species, *occidentalis* (Perg.), is also included (see Sakimura, 1940, p. 282). Whipple (1936) reported an experimental transmission of the spotted wilt virus by *T. tabaci* to garden pea in Wisconsin.

Taylor and Chamberlain (1937) and Chamberlain and Taylor (1938) demonstrated that the spotted wilt virus was transmitted by *Thrips tabaci* Lind. in New Zealand. They stated that *Frankliniella insularis* Frank. was not found there. Bonnemaison (1939) stated that transmission of the spotted wilt virus was made by *T. tabaci* in France. Moore and Anderssen (1939) of South Africa reported further tests with *Frankliniella schultzei* (Tryb.), and also reported an experimental demonstration of transmission by *T. tabaci,* and the probable identity of the Kromneck with the spotted wilt virus. McWhorter and Milbrath (1938) and Milbrath (1939) discovered in Oregon a new virus, tomato tip blight, which was stated to be closely related but distinct from the spotted wilt virus. Thrips transmission tests were made with mixed lots of several species, including *T. tabaci, Frankliniella moultoni* Hood, and *F. occidentalis* (Perg.). They concluded that *T. tabaci* is the chief vector but other species of thrips may also be vectors. Holmes (1939, p. 138) in his classification system of the viruses placed this virus as a strain of the spotted wilt virus. Norris (1943) presented the evidence that the tip blight virus is one of the component strains of the spotted wilt virus which is a compound entity.

The South American workers brought out a number of reports in 1937 and 1938. The disease had been known for some time under several different names, Corcova, Vira-cabeca, Necrose do topo, and Peste negra. This virus is now accepted as identical with, or a

separate strain of, the spotted wilt virus. Bennett *et al.* (1946, p. 26) who observed the disease at Tucuman, Argentina, stated recently, "it may be a strain, perhaps different from any yet described from other parts of the world." Fawcett (1938) of Tucuman reported an experimental transmission of the virus by *Frankliniella paucispinosa* Moulton, and a detailed description of his test was published later (Fawcett, 1940). At about the same time, the Brazilian workers also discovered that the disease is transmissible by *Frankliniella* sp. A series of their papers published are Forster and Costa (1938), Costa and Kiehl (1938) and Costa and Forster (1938). The species of *Frankliniella* involved was subsequently believed by the Brazilian workers to be *paucispinosa* (see Sakimura, 1940, p. 282). The earliest reference of thrips transmission in South America is that of Silberschmidt (1937) who simply cited the data collected by Costa and his co-workers before the originals had been published. Costa and Forster (1941) stated that *Thrips tabaci* which is very common in Brazil has not been studied in any experimental transmission test there.

In Hawaii, Parris (1940) and Sakimura (1940) presented the evidence for the co-identity of the Hawaiian yellow spot virus and the spotted wilt virus. The latter used the vector, *Thrips tabaci* Lind., throughout his experiments. McWhorter, who studied the tomato tip blight virus, expressed his opinion in correspondence with the reviewer in 1940 that symptomatologically the Hawaiian yellow spot virus more closely resembles the tip blight virus than the spotted wilt virus. Norris (1943) presented a new basis for the better understanding of the strain relationship existing between the allied viruses of the spotted wilt virus group. He separated several strains from the spotted wilt virus recovered from field-infected plants in Australia. One of the strains was identical with tip blight from Oregon. He stated that neither one of these strains has been found separately under natural conditions in Australia, and that the spotted wilt virus is not a single entity but a complex of closely related strains. He also stated that the variation in the symptoms of the spotted wilt virus can be simply explained by a variation in the ratio of the strains mixed.

In cooperation with Norris, the reviewer made a preliminary trial on the strain-splitting of the Hawaiian yellow spot virus. Norris wrote to the reviewer upon examining the data and photographs that the evidence is clear for the presence of the ringspot strain and necrotic strains, either necrotic or tip blight. He also stated that the tip blight strain is suspected to be suppressed to a very low concentration in the *Emilia* host commonly growing in the Hawaiian pineapple fields, but increasing of the concentration may possibly be made by a series of sap inoculations through a particular host sequence. The reviewer is now of the opinion that the yellow spot

virus is not the tip blight virus, as McWhorter suggested, but is the spotted wilt virus possibly different in strain composition from that of the typical one in Australia.

Khuduina (1941) reported a successful transmission by *Thrips tabaci* Lind. of a tobacco virus in Russia which he stated to be probably identical with the spotted wilt virus. Jones (1944) studied cineraria streak which was found to be caused by a strain of the spotted wilt virus and to be transmissible by *T. tabaci*.

Schussnig (1943) reported the *Lycopersicum* virus 7 from south Moravia and Czechoslovakia which was experimentally transmitted by *Thrips tabaci* Lind. He stated that the virus has analogies with, but is distinct from, the tip blight virus. Although further affinity was not mentioned by Schussnig, the virus, in the reviewer's opinion, is suspected to be another strain of the spotted wilt virus. This virus, which was called a mosaic, was first recorded by Baudye (1933). Frimmel and Lauche (1940) stated that a flower-infesting thrips is the vector of a tomato mosaic in Moravia. The tomato mosaic dealt with by Frimmel and Lauche may be the one referred to by Baudye, and also may be the same disease as the one subsequently demonstrated by Schussnig to be transmissible by *T. tabaci*.

There is one reference reporting a doubtful case of the spotted wilt virus. Serrano (1935) stated that yellow spot disease of pineapple identical with that reported from Hawaii was present in the Philippines; that the disease was transmitted by *Thrips tabaci* Lind. Carter (1939) who made observations in the Philippines concluded that the disease dealt with by Serrano is not yellow spot but another disease. Another reference on the related subject is that of Cook (1936) who seems to be confused in recognizing yellow spot on pineapple plants growing in Puerto Rico.

There are at least five different species of thrips mentioned in the references as the vectors of this virus. These should be re-examined under the new synonym established by the taxonomist. The reviewer was informed by Mr. Dudley Moulton of a synonym to be presented in his forthcoming monograph of the genus *Frankliniella*. According to him, the Australian *nigripes* (Girault) (=*lycopersici* Andrewartha; *insularis* Morison, nec Franklin) and the South American *paucispinosa* Moulton are synonyms for the South African *schultzei* (Tryb.). For the old synonyms of the Australian species, see Jensen (1946, p. 592). This new synonym is very significant because this offers a basis for a new interpretation of the facts. It indicates that a single species of *Frankliniella* transmits the separate strains of the virus, as claimed by workers, in the different districts throughout the world. In addition to a common vector in the southern hemisphere, *Frankliniella moultoni* Hood is a regional vector restricted in its distribution to the Pacific coast of North America. *F. occidentalis* (Perg.) is a color phase of *F. moultoni*. *Thrips tabaci* Lind. is a cosmopolitan vector throughout the world but no

confusion has been noted in the references of virus transmission.

In conclusion, there are three different species known to transmit the spotted wilt virus and its strains.

The non-vectors

Non-vectors of the spotted wilt virus may be considered in two general classes: thrips and insects other than thrips.

Experimenting with insects other than thrips, Hamblin (1921) and Noble (1928) in Australia found that the virus was not transmitted by a pentatomid bug (*Nezara viridula* L.) and a mirid bug, and an aphid, ? *Myzus persicae* (Sulz.) or *Macrosiphum solanifolii* (Ashmead) (= *M. gei* [Koch]). Then Pittman (1927) and Samuel, Bald and Pittman (1930) also reported negative results from a large number of test plants on which six species of insect were tested: 2 species of jassid leafhoppers; aphids, probably *Myzus persicae* and *Macrosiphum solanifolii;* a white fly (*Trialeurodes vaporariorum* [Westw.]); a red spider (*Tetranychus telarius* Linn.); and a mite (*Phyllocoptes lycopersici* Tryon). Illingworth (1931) of Hawaii stated that several preliminary tests with various species of insects and mites were made, but his tests consisted of mass transfers of field specimens.

Smith (1931a) in England tested two species of aphids, *Myzus persicae* and *Macrosiphum solanifolii.* He had negative results in most of the cases, but also had occasional positive cases with *M. persicae*. Later in another paper (Smith, 1932), he stated that his previous tests needed confirmation before being regarded as conclusive. However, his data were not confirmed by the ones previously reported by Samuel, Bald and Pittman (1930). Moore (1933) in South Africa did not make any tests along this line. Forster and Costa (1938) of South America recorded a mirid bug (*Dicyphus* sp.) and an aphid (probably *Aphis gossypii* Glov.) with negative results from a small preliminary test. Fawcett (1940) of South America reported negative results from preliminary tests with a mirid bug (*Eugylatus notatus* Distant), jassids (*Agalliana ensigera* Oman[10], *Empoasca* sp., and *Eutettix* sp.), aphids (*Myzus persicae* Sulz. and *Aphis rumicis* Linn.), and coleopterons (*Epitrix* spp. and *Diabrotica punctata*[11]).

These tests made by the various workers include mites, white fly, aphids, leafhoppers, and plant bugs which well represent all the known groups of insects related to the plant virus transmission. It is quite certain that some of these tests were strictly preliminary in nature but the others were not, particularly so with the aphid group. Although the available data are not extensive and conclusive, they are strongly suggestive that insects other than thrips may have no

[10] For the name of this species, see also Oman, Rev. de Ent. 4: 336, 1934.

[11] The validity of this name is doubtful. (See Blackwelder, U. S. Nat. Mus. Bull. **185**: 679-686, 1946.) There is a South American species infesting tomato with an allied name of *D. limitata* (Sahlberg) (= *quindecimpunctata* Germ.).

vector relation with the spotted wilt virus. A fact that supports the above deduction is that there is no virus known, except the few cases aforementioned, to be transmissible by insects which belong to more than one group. This is particularly true with the persistent type of virus which has a highly developed specificity between the vector and the virus, and the spotted wilt virus belongs to this group.

So far as thrips are concerned, very little work has been done on species other than the three known vectors. Samuel, Bald and Pittman (1930) attempted to test several species which died before the tests were complete; they are *Thrips* sp., *Thrips nigropilosus* Uzel, *Haplothrips* sp., and *Taeniothrips simplex* (Morison). However, these workers tested a large number of *Othinanaphothrips tersus* (Morison)[12] in adult and larval stages which conclusively gave negative results. Bonnemaison (1937) stated that *Frankliniella intonsa* (Tryb.) which was tested in France appeared not to transmit the virus. McWhorter and Milbrath (1938) stated that *Anaphothrips obscurus* (Müll.) was present in the thrips lots tested but nothing was known about the ability of the species.

Sakimura (1940, 1946) made efforts in testing the other thrips for their possible vector relationship. He adapted a new scheme of test which had never been attempted by the other workers. A mixed colony of the known vector species and the species to be tested is established on the diseased plants. and insects of each species are separately transferred to the test plants. With this procedure, the evidence for availability of virus within the source plants is readily provided by the results of the known vector species. When the test is repeated with adequate numbers of test plants and test insects, the results of such tests, in the reviewer's opinion, are conclusive. It will be desirable to repeat the tests on more than one species of the test plants. He has already tested *Thrips nigropilosus* Uzel and *Frankliniella sulphurea* Schmutz, which are both widely distributed general feeders, and *Hercinothrips femoralis* (Reuter) and *Anaphothrips* (*Chaetanaphothrips*) *orchidii* (Moulton), which are both common greenhouse species throughout the world; all were proved to be non-vectors.

Although the negative vector relation has been demonstrated with five or six different species of thrips, the fact that there are three vector species still strongly suggests a possible presence of other vector species of thrips. Thrips, irrespective of the vector or the non-vector species, may equally be able to ingest the virus, but a specific permeability of the gut wall which allows the virus to penetrate, might determine the vector species. The number of thrips species associated with plants is very large; a few particular species should have permeability similar to that common in the three known

[12] For the name of this species, see also Morison, Bull. Ent. Res. **21**: 9, 1930; Crawford, Proc. Ent. Soc. Wash. **45**: 151, 1943.

vectors. Suspicion is particularly placed on the members of the two genera, *Frankliniella* and *Thrips,* to which the known vectors belong. Further studies along this line are highly desirable.

The mode of transmission

The spotted wilt virus is acquired by the vector in its larval stage only, and the adults emerged from such larvae remain infective for a long period although no longer able to acquire further virus. This is a pronounced peculiarity and no analogous case has been seen among the insect vectors of the plant viruses, except an allied case of *Perkinsiella saccharicida* Kirk. with Fiji disease. This fact was demonstrated with *Thrips tabaci* Lind. by Smith (1932) in England, and Linford (1932) in Hawaii; as well as with *Frankliniella schultzei* (Tryb.) by Bald and Samuel (1931) in Australia, and Moore (1933) in South Africa; and also with *Frankliniella moultoni* Hood by Whipple as cited by Bailey (1935) in California.

Several different hypotheses have been advanced for the mechanism of the negative acquisition by adult thrips, but none has been experimentally demonstrated. Linford (1932) advanced the digestion theory; that is, digestion may destroy the virus ingested during the adult stage. Smith (1932; 1933, p. 152) and Bailey (1935) suggested morphological differences as the reason. Points which can be ruled out are the feeding mechanism and the plant tissues to be fed because they are practically the same in both larval and adult stages. Lately, Bawden (1939, p. 71) expressed another view, the permeability theory, based on new data. He stated that the virus may not be destroyed by digestion when ingested during the adult stage, but may be unable to penetrate through the gut wall. Bawden's view is particularly based on the findings of Bennett and Wallace (1938) on the presence of the virus in the alimentary tract of the non-vector insects; also of Storey (1933) who punctured the gut wall of inactive insects (a strain unable to acquire the virus) and rendered them active. It would be highly interesting to make a test to determine whether or not such puncturing will enable the adult thrips to acquire the virus.

The length of the retaining period of the virus by the vector thrips has been studied by several workers. The length of the period is usually erratic; the infective adults sometimes remain viruliferous throughout their life, or lose their infectivity before their natural death. The maxima in days tested so far are more than 24 days with *Frankliniella schultzei* (Samuel, Bald and Pittman, 1930; Bald and Samuel, 1931); 30 days both with *Thrips tabaci* (Carter as cited by Bailey, 1935) and with *Frankliniella moultoni* (Whipple as cited by Bailey, 1935).

The latent period in the vector body, the delay between the time when the vectors acquire the virus and when they are able to transmit, was also studied by the various workers. The minima in days

reported are five days (Smith, 1932) and about 10 days (Linford, 1932) with *Thrips tabaci;* five days with *Frankliniella schultzei* (Bald and Samuel, 1931); and about 10 days with *Frankliniella moultoni* (Whipple as cited by Bailey, 1935). Moore and Anderssen (1939) observed an occurrence of such a period with *F. schultzei* but did not determine its length. The similarity seen among the three vectors in regard to the negative acquisition by the adult insects, the retaining period and the latent period are notable. The specificity, if any, between three vector species appears to be insignificant. A slight divergence seen in the latent period was possibly caused by different designs of the tests.

In view of the fact that the vectors have a long retaining period and a definite latent period, the spotted wilt virus is a persistent type of virus. However, the virus is, as suggested by the type of symptoms, doubtless a parenchyma-phloem type in the tissue relation. Thrips which are parenchyma feeders readily acquire the virus from the parenchyma tissues. This fact indicates that the spotted wilt virus, on the other hand, also has characteristics common to the non-persistent type. Furthermore, sap-transmissibility of the virus supports the above conclusion. The sap-transmission is readily made in all the strains of the virus except the tip blight virus which was reported by Milbrath (1939) to be difficult to transmit. The yellow spot virus was once reported by Carter (1935) to be difficult to transmit on pineapple plants, but Parris (1940) stated that it is not so on several solanaceous plants.

In conclusion, the spotted wilt virus belongs to the persistent type of viruses, but has definite affinity to the non-persistent type in aspects of mouth-structure of the vectors, and tissue relation and sap-transmissibility of the virus. It is apparently an intermediate type between both categories and no analogous case has been known.

A local problem

Attention should be called to the fact that the problem of insect vectors of the spotted wilt virus is directly of local interest. This virus disease has been known here in Hawaii for about 20 years. At the time of its first discovery, the disease was once gravely feared as a major disease of pineapple plants. However, with the exception of some minor localized outbreaks here and there, this disease has rarely proved to be serious in Hawaii. The status of the disease on the tomato crop is different from that on pineapple. The tomato crop in the past several years has suffered extensively in several different districts.

Severeness of the virus diseases is largely governed by the factors involving the insect vectors which spread the diseases. There is in Hawaii at present only one species of the three known vectors, that is, *Thrips tabaci* Lind. It is quite natural that the situation would be drastically changed if additional vectors were introduced into

Hawaii. The host preference, reproductive potential, and resistance to ecological factors would vary with different species of vector and other vector species could be more destructive than the one we already have here. It is quite certain that pineapple, tomato and other crops would suffer more than ever from such an invasion of additional vectors.

The second vector, *Frankliniella moultoni* Hood, is a common species in the Pacific coast region. It is a constant menace due to the possibility of invasion. Fortunately no evidence has been found indicating that this species has become established in Hawaii. The third vector, *Frankliniella schultzei* (Tryb.), is known to be distributed as near to Hawaii as in New Guinea.[13] This is another menace. There is one recent instance of thrips invasion from the south; that is *Frankliniella sulphurea* Schmutz. The nearest locality of its distribution known before its invasion into Hawaii was also New Guinea.[13] Consequently, we must recognize the very real possibility of a similar invasion by *F. schultzei.*

As was discussed previously there is a good reason to believe a possible presence of additional vectors, particularly among the members of the genera *Frankliniella* and *Thrips*. Therefore any species of these two genera which has no known status for the vector relationship with the spotted wilt virus will be a dangerous addition to the local fauna, if and when it should be introduced here. As was cited a few lines before, *Frankliniella sulphurea* is a good example. This species is extremely polyphagous in host range and abundant in number; that would qualify this species to be a possible dangerous vector. In view of this fact, when this species was first discovered in 1942, prompt attention was paid to testing its vector relationship with the spotted wilt virus. Fortunately the test revealed that the species is not a vector (Sakimura, 1946).

There is another case of a new introduction of *Frankliniella fusca* (Hinds) (Sakimura, 1947) which was discovered on imported narcissus plants at Hilo, Hawaii, in late 1945. So far, no evidence has been found of its spreading from the original site of the discovery or its firm establishment in the vicinity. This species, which is also a general feeder, should be tested for its possible vector relationship. *Frankliniella formosae* Moulton and *F. tenuicornis* (Uzel) as well as several native species of the genus *Thrips,* none of which have been tested for their vector relation, are common species in Japan and China. They are also potential invaders because of their geographical nearness to Hawaii.

In conclusion, Hawaii should be well protected from possible invasion by other species of tiny thrips which may accentuate the seriousness of the destructive spotted wilt disease in Hawaii.

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[13] Moulton notified the reviewer that *Frankliniella clitoriae* Moulton and *F. pembertoni* Moulton, both reported from New Guinea, are synonyms for *F. schultzei* (Tryb.) and *F. sulphurea* Schmutz, respectively.

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ADDENDUM

Dickson, R. C. and Johnson, M. M. (Insect investigations in relation to quick decline. Calif. Citrograph 32: 159-162. 1947) stated that four species of thrips were tested for vector relation with citrus quick decline which was believed of virus origin. This paper is a progress report and the final result of the test was not given.

INDEX TO THRIPS SPECIES

A new Procecidochares from Eupatorium Stems (Diptera: Tephritidae)

By ALAN STONE
Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

The fruit fly here described was first discovered in Mexico in 1944 forming a stem gall on *Eupatorium adenophorum,* and it has since been introduced into the Hawaiian Islands. It apparently has become established there, and since it may prove to be of value in the control of its host, which is a plant pest in Hawaii, a name for it becomes desirable.

Procecidochares utilis, new species

Female. *Head:* Width 1.26 mm.; width of vertex across median ocellus 0.49 mm.; somewhat narrowed below; eye height 0.84 mm.; length of antenna 0.40 mm. Occiput dark, with thin gray pollinosity, this color also covering the ocellar region and forming a narrow stripe on each side to the upper orbital bristles; vertex yellow-orange, yellower along eye margins; lunule, frontoclypeus, and genae yellowish white; antenna orange, the first two segments with dark setae; arista dark with yellowish base; palpi yellow-orange with dark-brown setae; postvertical and postorbital setae yellowish white, the vertical, ocellar, and orbital bristles black; two or three lower orbitals.

Thorax: Black, the notum shining except for the humeri, notopleura, transverse suture, and a median stripe lying between the dorsocentral bristles, which are subshining to distinctly gray as a result of very fine, closely appressed microsetae; these non-shining parts with flattened, suberect, white setae forming a more or less distinct pattern, consisting of a narrow median stripe which forks before the scutellum, a dorsocentral stripe on each side diverging laterally to form a strong row broken medially in front of the scutellum, and a border around each presutural shining area; also a few in an oblique line on each presutural shiny area, and a few at the base of the supra-alar bristle; all bristles black; two or three dorsocentral bristles, the presutural sometimes lacking; pleuron with thin gray pollinosity and flattened whitish setae; one posterior sternopleural bristle. Postnotum black; metanotum with gray pollinosity. Wings (fig. 1) with brown pattern as figured; no setae on vein R_{4+5}. Halteres yellowish white, the knob sometimes darkened. Legs yellow-orange, the coxae and basal half or more of the femora usually infuscated.

Abdomen: Black; tergites 1 and 2 and anterior portions of tergites 3 and 4, widening medially, subshining; rest of dorsum and the sternites shining; dorsum of abdomen with abundant white, flattened setae; ovipositor sheath and venter with very fine pale setae; ovipositor sheath 0.84 mm. long, about twice as wide basally as at apex; ovipositor 0.63 mm. long.

Male. Apparently identical with female except for genital structures. Presutural dorsocentral bristles less often present.

[1] Aldrich, J. M. U. S. Nat. Mus. Proc. **76**(2): 1-13, 1929.

Type Material. All reared from stem galls on *Eupatorium adenophorum* by N. L. H. Krauss. *Holotype* ♀, Cuernavaca, Morelos, Mexico, July 31, 1944 (U. S. National Museum Cat. No. 57981). Paratypes, 1 ♀, 1 ♂, same data as holotype; 4 ♀♀, 1 ♂, Cuernavaca, August 13, 1944 to October, 1944; 14 ♀♀, 11 ♂♂, Tantalus, Oahu, Hawaii, March 1946. Paratypes in the U. S. National Museum and the collection of the Hawaiian Sugar Planters' Association.

This species is quite distinct from any of the described species. In Aldrich's[1] key to the North American species, certain specimens with yellow legs might run to *flavipes,* but *flavipes* is smaller with a different scutal pattern. Specimens with the normally darkened femora would go to *anthracina* or *pleuralis,* depending upon the presence or absence of presutural dorsocentral bristles, but *utilis* differs from the former in having the pleura pollinose and the ovipositor sheath shorter, and from the latter in the narrower posterior hyaline triangle of the wing and the shorter ovipositor sheath.

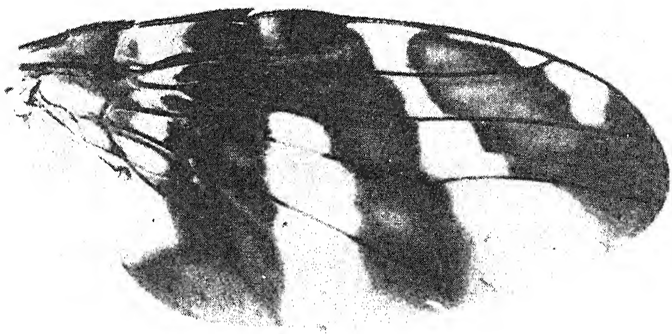

Figure 1. Wing of *Procecidochares utilis* n.sp.

Elaphria nucicolora (Guenée), a Recent Immigrant to Hawaii (Lepidoptera: Agrotidae: Acronictinae)

By O. H. SWEZEY

(Presented at the meeting of July 8, 1946)

This new immigrant moth first appeared in a light trap at Hickam Field, June 5, 1945. It was a very much abraded specimen, but there were enough features of structure to distinguish it as some hitherto unknown moth. Again it was taken in light trap at Wheeler Field, December 18, 24, 26, 1945 and January 18, 1946. On the last date, it was taken also in light trap at Kahuku. Then it was taken in light trap at Waipio, January 25, February 12 and March 5, 1946; at Wahiawa, March 15, April 14, 17, 18 and May 13, 1946; and at Kalihi, June 12, 1946. Among the later captures were some that were in perfect enough condition for recognition; accordingly eight of the best specimens were sent to the U. S. Bureau of Entomology and Plant Quarantine for determination. It was determined by Mr. Carl Heinrich as *Elaphria nucicolora* (Guenée), a species occurring in Florida, Texas, Bahamas, Jamaica and on south into South America as far as Trujillo, Peru and Bahia, Brazil.

This moth was described by Guenée in the genus *Monodes*, of which genus it was the type species. It remained in this genus for a considerable period. In 1909, Hampson listed it with 87 other species of *Monodes* in Catalogue of Lepidoptera, Phalaenae of the British Museum. It is also listed in the same genus in the Barnes and McDunnough Check List of North American Lepidoptera, 1917.

In a paper on "Sugarcane Pests in Florida" by Ingram, Jaynes and Lobdell, presented at the meeting of the International Society of Sugar Cane Technologists in Louisiana, October, 1938, *Elaphria nucicolora* is used as the name of this moth which is included with several other moths which "have assumed cutworm habits in sugar cane in Florida." This is the only reference which I have found in literature using the genus *Elaphria* in the place of *Monodes*, but I presume that somewhere there is recorded the reason for the change.

Another species (*Monodes agrotina* Guenée) is mentioned by Holloway as having been recorded by Moore of British Guiana as the "dead cane moth," the caterpillar of which feeds on "dead

and decaying cane stumps and even on dry trash." It is parasitized by a tachinid fly. (Facts about Sugar, 31 : 183, 1936.)

It is possible that *Elaphria nucicolora* may be found to be only a scavenger, but at the moment none of its caterpillars has been found, so nothing is yet known of its habits here. It is to be hoped that it will not be found to have cutworm habits in our cane fields.

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A New Neoclytarlus from Chenopodium oahuense (Coleoptera: Cerambycidae)

By O. H. SWEZEY

(Presented at the meeting of August 12, 1946)

Neoclytarlus lookii n. sp.

Male 6-9 mm., female 7-12 mm. (The smaller of both sexes were depauperate specimens.) Conspicuously dimorphic in color similarly to *N. chenopodii* Perkins, which was reared from the same species of host plant on the island of Oahu.

Male: pale brown with a nearly uniform clothing of appressed white hair scales, sometimes somewhat more dense on the elytra along the apical half of the suture; underside and legs hardly less densely clothed with white hair scales; in a few specimens the clothing is pale yellowish; pronotum without longitudinal vittae of denser clothing; median dorsal crest of pronotum with a transverse crest near anterior margin and two similarly behind the middle, hardly raised between these and the anterior crest; the raised portions are more prominent than in *chenopodii.* Antennae and legs pale brown, the clavate portion of the femora a little darker, and thicker than in the female.

Female: black and somewhat shiny, mostly bare, or with sparse appressed white hair scales and varying between this and fully-clothed specimens, and having the dense stripe along the suture of elytra which is characteristic in species of *Plagithmysus,* and the pronotum with lateral vitta on each side of the median crest, the latter proportionately wider than in the male. Pronotum and elytra finely and densely punctate. Antennae and legs dark brown to fuscous, the clavate portion of femora nearly black. The club of hind femora is not so conspicuously thickened as is usual in *Neoclytarlus,* but approaches the form of femora characteristic in *Plagithmysus.*

Holotype female, allotype male and numerous paratypes of both sexes reared from stems of *Chenopodium oahuense* growing on the central plateau of Hawaii along the "saddle road," especially in the vicinity of the Pohakuloa Camp.

Holotype and allotype in type collection of Hawaiian Entomological Society.

The species is named for Mr. Wm. C. Look who first collected specimens of beetles resting on the twigs and stems of *Chenopodium oahuense,* June 2, 1946. Again on August 1, he collected beetles, and stems of the plant containing numerous larvae and pupae, which were turned over to Mr. Clifton J. Davis of the Hawaii National Park for rearing. Beetles issued by the hundreds. On August 3, Messrs. F. A. Bianchi and E. C. Zimmerman also collected infested stems from the same region, which were forwarded to me for rearing. From this material, during August and up to September 18, there issued 156 beetles (73 females and 83 males). Parasites issued also: 4 females and 3 males of *Eupelmus leptophyas* Per-

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kins; and 26 females and 7 males of a larger species of *Eupelmus* which appears to be different from any previously described by Dr. Perkins. The larvae of this species were found to have fed on the pupae of the host. Mr. Look found parasites numerous in the larval tunnels in the stems. Among them were *Sierola* sp., *Sclerodermus* sp. and the *Eupelmus* sp. above.

This is another case of an endemic Hawaiian cerambycid attacking living plants. The larvae were found feeding in the living stems and branches of the shrub *Chenopodium oahuense,* resulting in their dying back, stunting the growth, and many subsequent branches coming out below, if the plant was not entirely killed. The severity of infestation is indicated by the count of 40 exit holes in a 10-inch piece of stem. When the twigs and branches die and dry up before the larvae have become full-fed, the result is depauperate specimens, often of very small size.

Two New Hawaiian Moths on Chenopodium oahuense

By O. H. SWEZEY

(Presented at the meeting of December 9, 1946)

Family PLUTELLIDAE

Mapsidius chenopodii n. sp.

Male and female, 11-13 mm. Antennae dark fuscous, basal joint white beneath, slender in female, in male slightly thickened. Palpi dark fuscous, whitish on inner side. Head smooth, slaty, with a few sparse white scales on face. Thorax slaty, patagia tipped with white. Fore wings suffused with mixed fuscous and white scales, with several concentrations of the fuscous scales into small black spots irregularly placed, cilia pale brownish. Hind wings slaty, with a few sparse white scales, cilia pale brownish. Abdomen light brownish, paler beneath. Legs fuscous, femora white beneath, tarsi ringed with white. One male is mostly slaty, with very little of the white scales.

Holotype male; paratypes males and females.

Holotype in the type collection of Hawaiian Entomological Society.

Described from five males and four females reared by Wm. C. Look from larvae on foliage of *Chenopodium oahuense* at various places along the "saddle road" at and near Pohakuloa Camp, Hawaii, June to September, 1946.

The larvae of the four other species of *Mapsidius* all feed on the foliage of *Charpentiera*.

Family AGROTIDAE

Feltia lookii n. sp.

Male and female, 32-35 mm. Head and thorax grayish fuscous, thorax densely covered with hair scales which are white-tipped and with two slender points; antennae gray, in male bidentate with triangular processes tufted with setae; labial palpi grayish fuscous, porrect, terminal joint short. Fore wings grayish fuscous, some slight suffusion of whitish ochreous in basal region, veins mostly marked with dark fuscous lines, orbicular and reniform combined into an elongate black-outlined mark which is narrowed in middle portion and posteriorly slightly widened (not abruptly dilated as in *dislocata*), terminal margin with a series of black marks between the veins; cilia gray, whitish at base and tips. Hind wings nearly uniformly grayish fuscous, slightly darker terminally and on veins, a whitish ochreous subcostal streak on basal third; cilia as in fore wings. Legs grayish fuscous. Abdomen gray above, hairy, terminally ochreous in male.

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Holotype male collected by Wm. C. Look in the vicinity of the Pohakuloa Camp, on the "saddle road," Hawaii, September 20, 1946. At the same time agrotid-like caterpillars different from any species known to me were collected on *Chenopodium oahuense*, but Mr. Look and myself failed to rear any of them. Yet it seems a possibility that they could have been the larvae of *Feltia lookii*. Allotype female, a specimen in the collection of the Hawaiian Sugar Planters' Experiment Station, labelled "Waimea, Hawaii, 10-11-08," apparently collected by Swezey. This female had been placed with specimens of *Feltia dislocata* which it greatly resembles though of smaller size and the combined orbicular and reniform mark in fore wing is of different form as described above.

Holotype in the type collection of the Hawaiian Entomological Society.

Synonymy of Two Common Moths of Stored Food Products

By O. H. SWEZEY

(Presented at the meeting of December 9, 1946)

In a recent paper by Dr. A. Steven Corbet and Mr. W. H. T. Tams: "Keys for the Identification of the Lepidoptera infesting Stored Food Products" (Proc. Zool. Soc., Ser. B, **113**: 55-148, 1943), the names for two moths are different from what have been in use in Hawaii, and it is presumed that our names should be treated as synonyms.

Endrosis sarcitrella (Linn.), p. 103
= *Endrosis lactella* (Schiff.)

Setomorpha rutella Zeller, p. 111
= *Setomorpha dryas* (Butler) Walsm.
= *Setomorpha insectella* (Fabr.) Walsm.

A Eumenes Wasp and Six Adventive Ichneumonidae New to Hawaii (Hymenoptera)

By HENRY TOWNES
Takoma Park, Maryland

(Presented by Mr. Van Zwaluwenburg at the meeting of December 9, 1946)

An opportunity to study the ichneumonids in the collections of the Hawaiian Sugar Planters' Experiment Station and of the Bishop Museum in Honolulu disclosed a number of species adventive to Hawaii whose presence there had not yet been reported. The described species among them are reported here. In addition a species of *Eumenes* was collected for the first time.

On September 7, 8 and 9, 1946, about six specimens of a large black and orange *Eumenes* were seen near Pearl Harbor, Oahu, around flowers at the Makalapa officers' quarters, and drinking water from a soaked fiber mat at a nearby swimming pool. Two males and a female were caught. Another female was seen to fly to its mud nest on a post of a third floor balcony. The nest was of four oval cells in a row closely plastered together. One cell was still open but quite full of caterpillars. Besides a wasp larva in each cell, the nest contained about 25 larvae of *Anacamptodes fragilaria* (Grossbeck), a recently introduced geometrid.

Subsequently a specimen sent to Dr. J. C. Bequaert was determined by him as *Eumenes pyriformis petiolaris* Schulz, described (Berlin Ent. Zeit., 49: 217, 1904) from Finschhafen, New Guinea, as *E. latreillei* var. *petiolaris*. It is a common wasp in New Guinea, and Dr. Bequaert has seen it also from the Solomons and Fiji. We may assume that it arrived during the war from the New Guinea area, probably as nests on stores, mechanized equipment or ships coming to Pearl Harbor.

Rhembobius abdominalis pacificus (Harrington) 1894. This subspecies is native to the western United States and Canada, where it has been reared from two syrphids which attack bulbs (*Citibaena strigata* and *Merodon equestris*).

Hawaiian record: ♂, ♀, at filter mud, Hilo Sugar Co., Hilo, Hawaii, July 1932, F. X. Williams (H.S.P.A.).

Gambrus ultimus (Cresson) 1864. This is a species native to the United States east of the Rocky Mountains. It is common among sparser, more open vegetation and is one of the species frequently reared by economic entomologists. Published hosts

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include Olethreutidae (*Ancylis comptana, Grapholitha molesta,* and *Polychrosis viteana*) and Pyraustidae (*Phlyctaenia tertialis*).

Hawaiian records: 2♂, Kokee, Kauai, July 11, '37, E. C. Zimmerman (Bishop Mus.); ♀, Kokee, Kauai, Jan. 8, '44, N. L. H. Krauss (H.S.P.A.); ♂, on grass, Mauna Loa trail, Kilauea, Hawaii, July 4, '34, O. H. Swezey (H.S.P.A.).

Melanichneumon rubicundus (Cresson) 1864. This species is native to the northeastern United States and adjacent Canada, where it occurs among grass. In North America it is most common in the fall.

Hawaiian records: ♂, Hookomo, Hawaii, August 4, '35, R. L. Usinger (Bishop Mus.); ♀ Humuula, Hawaii, July 30, '35, E. H. Bryan, Jr. (Bishop Mus.).

Syrphoctonus maculifrons (Cresson) 1865. This species is native to the western half of the United States and southwestern Canada. Like *Diplazon laetatorius,* its ally in Hawaii, it parasitizes a wide variety of aphid-feeding Syrphidae. Published host records include *Cheilosia alaskensis, Cheilosia hoodiana, Eupeodes volucris, Metasyrphus* sp., *Scaeva pyrastri,* and a species of *Syrphus* (all Syrphidae).

Hawaiian record: ♂, Oahu, April 5, '13 (Bishop Mus.).

Hypsicera femoralis (Fourcroy) 1785. This species is a cosmopolitan parasite of clothes moths, usually collected in buildings.

Hawaiian records: ♀, on window, Honolulu, Oahu, July 26, '33, R. H. Van Zwaluwenburg (H.S.P.A.); ♀, at window, Hawaiian Sugar Planters Experiment Station, Honolulu, Oahu, August 11, '33, F. X. Williams (H.S.P.A.).

Anomalon californicum (Cresson) 1878. This species is native to Arizona and the southern half of California. There are no host records for this species but others of the genus have been bred from larvae of Elateridae.

Hawaiian records: ♀, Niihau, early October, 1945, Stephen Au and Q. C. Chock (Bishop Mus.); 2♀, flying over *Portulaca oleracea* on the beach at the end of Channel St., Honolulu, Oahu, April 6, '46, H. Townes (Washington Mus.); ♀, flying along roadside, Koko Head region, Oahu, April 19, '46, H. Townes (H.S.P.A.).

Notes on Graptostethus in Hawaii (Hemiptera: Lygaeidae)

By ROBERT L. USINGER
U. S. Public Health Service

(Presented by Dr. Swezey at the meeting of April 8, 1946)

Graptostethus bugs are the most spectacular of recent hemipterous immigrants to the Hawaiian Islands. They were first recorded from Oahu in 1943 (Proc. Haw. Ent. Soc., **11**: 284). By 1945 they had become firmly established on Oahu and Kauai and had been investigated in some detail by Dr. O. H. Swezey. In Swezey's excellent paper (Proc. Haw. Ent. Soc., 12: 335-340, 1945) the distribution of the bugs was summarized, *Ipomoea tuberosa* was found to be a preferred host, and two very distinct color variations were described and figured.

Specimens of Hawaiian *Graptostethus* tentatively identified as *Graptostethus servus* (Fabr.) were referred to me some time ago with the request that I determine what name or names should be used for the forms occurring in the Hawaiian Islands. I have now had an opportunity while visiting the U. S. National Museum to compare the Hawaiian forms with specimens from elsewhere in the Pacific and Orient. The results as given below require a change in name from *Graptostethus servus* (Fabr.) to *Graptostethus manillensis* (Stål).

DISCUSSION

W. E. China (Insects of Samoa, **2**, fasc. 3, pp. 115-116, 1930) studied Pacific island *Graptostethus* and concluded that Samoan and Fijian specimens were referable to Stål's *nigriceps* which was originally described from Guam and was considered by Stål as a variety of *servus*. Mr. China raised Stål's variety to a full species and pointed out several constant characters in which it differs from typical *servus*.

It now becomes necessary to raise Stål's other variety (Stål, Enum. Hemipt., 4: 117, 1874), *manillensis*, which was originally described from the Philippines (Stål, Freg. Eugenies Resa, Ins. Hem., p. 240, 1859) to a full species. This action is necessary because true *servus* from China differs from the long series of *manillensis* before me in several important characters as follows: the head of typical *servus* is distinctly marked with black at the base and this black continues forward along the clypeus. The abdomen

is black over the entire venter except narrowly along the lateral margins, and the body is clothed with white, relatively long hairs. *Manillensis,* on the other hand, varies in color as illustrated by Swezey but has the head reddish with black only at the tip of the clypeus or sometimes throughout the clypeus and with black around or just behind the ocelli. The abdominal venter is reddish throughout and the pubescence is extremely short, without conspicuous pale hairs projecting from the pronotal margins and elsewhere.

I know *manillensis* only from Hawaii and from Negros, Leyte, and most typically and in greatest abundance, from Luzon. Both color varieties occur in the series of several hundred specimens from both Oahu and Luzon, and occasional specimens are seen in which the clavus and corium are entirely but only faintly infuscate. The exact nature of these variations is not known and can only be determined by experimental crossing of the various types.

I have seen typical *servus* from China, Formosa, Java, Singapore, and Mindanao. Hoffman (Lingnan Science Jour., 13: 171-176, 7 figs., 1934) has studied the life history of this species and records it from *Ipomoea cairica* (L.) Sweet.

Some Elaterid Beetles from Australia and New Guinea

By R. H. VAN ZWALUWENBURG

(Presented at the meeting of November 18, 1946)

Through the courtesy of E. C. Zimmerman, there has recently been submitted for study a collection of some 400 Elateridae from the United States National Museum. These were collected by Mr. Borys Malkin while on duty with the armed forces in Australia and Dutch New Guinea during the early months of 1945.

Two groups of elaterids are notably developed in Australia: the *Adelocera-Compsolacon* complex (with 109 described species) and the genus *Conoderus* (with 131 species from Australia). Probably more remain to be described, especially from the less well-collected regions in the northern and western parts of the continent. The same remarks are true in less degree for *Cardiophorus* and *Platynychus.* A number of species already described are probably present in this collection, but owing to the difficulty of their study the present writer is reluctant in many cases to make specific determinations until he has access to the scattered type material, or at least to more extensive named collections. Therefore nearly one-third of the Malkin collection has been set aside for later study, and discussion here is confined to identifications in which the writer feels a reasonable confidence.

Types of material described here have been deposited in the U. S. National Museum. The illustrations were prepared by James T. Yamamoto of the H.S.P.A. Experiment Station staff.

Agrypnus mastersi Macleay

One specimen, Sir Graham Moore Is., West Australia, Feb. 20.

Agrypnus resectus Candèze

Two specimens, Hollandia, Dutch New Guinea, April and June.

Adelocera socia (Candèze)

One specimen, Darwin, No. Territory, Australia, March 19.

Compsolacon gracilis (Candèze)

Thirty-six specimens, Hollandia, April. According to R. J. A. W. Lever (in correspondence), in the Solomons the larvae of this species are a pest of peanut plants.

Compsolacon gracilis var. **specularis** nov.

This differs from typical *gracilis* as follows: Slightly behind the middle of the disc of the pronotum, on either side, each separated from the nearer lateral

margin by a distance slightly less than its own diameter, are two, more or less round, glistening areas, coalescent along the median line of the disc, and slightly raised above the surrounding surface. Under higher magnification these smooth areas reveal extremely fine punctulations, but the general effect as ordinarily seen is shiny and impunctate.

U. S. N. M. No. 58272.

Described from a holotype female, Hollandia, Dutch New Guinea, April; and five paratypes (all probably females) with the same locality label and date. The general pronotal punctuation of the variety *specularis* is somewhat finer than in typical *gracilis*, being like that described by Schwarz for the synonymous *gracilentus*. The median area of the penultimate abdominal sternite is impunctate, as in *gracilis*. In the absence of males it is impossible at this time to compare the aedeagus of *specularis* with that of *gracilis* concurrently taken in abundance in the same locality.

Compsolacon lateralis (Schwarz)

Nine specimens, Townsville, Queensland, Australia, Feb. 5. According to McDougall (33rd Ann. Rpt. Bur. Sugar Expt. Stas., Queensland: 66, 1933) the larvae occur in sugarcane soils, but are not a serious pest of that crop. The adults are most numerous toward the end of the wet season.

Compsolacon semivestitus (Elston)

One specimen, Townsville, Queensland (one of the type localities), Feb. 5. It agrees well with Elston's description, but the sides of the prothorax are distinctly crenulate, especially on the basal half, a character not mentioned in the original description.

Alaus infumatus Candèze

One male, Hollandia, Dutch New Guinea, April.

Alaus obliquus Candèze

One female, Hollandia, April.

Pseudotetralobus australasiae (Gory)

One male, Anjo Peninsula, West Australia, Feb. 15.

Simodactylus pembertoni Van Zwaluwenburg

Four specimens, Hollandia, April. Comparison of these specimens shows close agreement with the holotype female from the vicinity of Rabaul, New Britain, in the type collection of the H.S.P.A. Experiment Station, Honolulu. Its capture in New Guinea marks an extension of its known range.

Conoderus corniculatus (Candèze)

Two specimens, Hollandia, April.

Conoderus cristatus (Candèze)

One specimen, Hollandia, April.

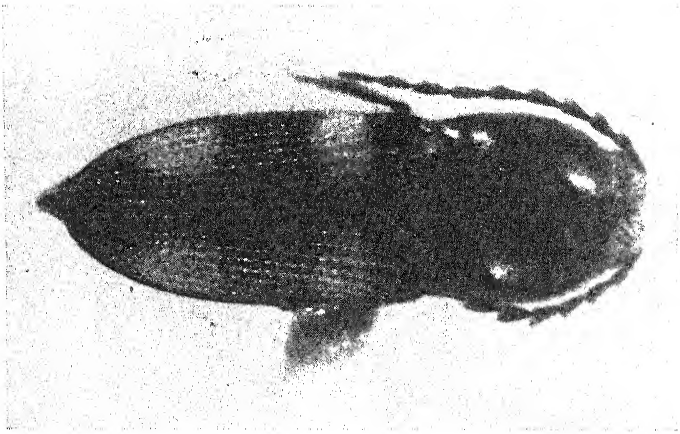


Figure 1. *Cardiophorus elevatus* n. sp.

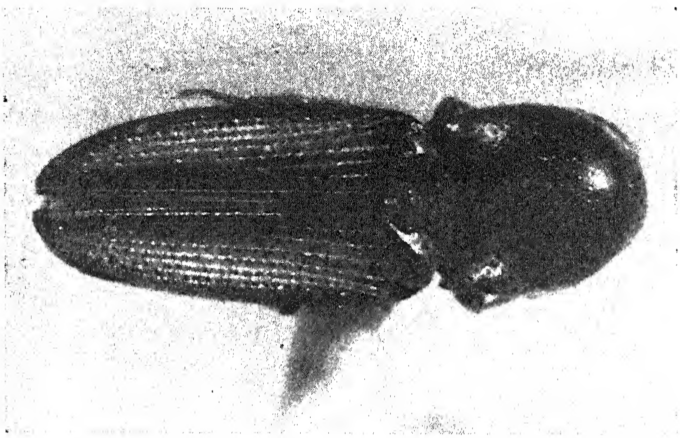


Figure 2. *Cardiophorus malkini* n. sp.

Conoderus fortis (Blackburn)

Four specimens, Anjo Peninsula, West Australia, Feb. 15; two, Sir Graham Moore Is., West Australia, Feb. 20; one, Darwin, No. Territory, March.

Conoderus umbraculatus (Candèze)

Seven specimens, Hollandia, April. Another specimen from Hollandia agrees well with the rest of the series, except that it has the pronotal punctation distinctly double, as in the subgenus *Heteroderes*.

Conoderus variegatus (Blackburn)

Four specimens, Darwin, No. Territory, March.

Conoderus vuilleti (Fleutiaux)

Sixteen specimens, Hollandia, April. This is the species described as *Monocrepidius flavobasalis* by Heller in 1914, a name preoccupied by *M. flavobasalis* Schwarz, 1907.

Conoderus (Heteroderes) carinatus (Blackburn)

Four specimens, Townsville, Queensland, Feb. 5; one, Darwin, No. Territory, March.

Melanoxanthus exiguus Van Zwaluwenburg

A specimen from Hollandia, April, agrees closely with the holotype male from Koitaki, New Guinea, in the type collection of the H.S.P.A. Experiment Station.

Cardiophorus elevatus n. sp. (Figure 1)

Convex; shiny, especially on pronotum. Generally black with following exceptions: (1) pronotum sometimes darkly rufous; (2) two yellowish areas on each elytron: one, on anterior third, rounded behind, generally transverse, extending from 2nd or 3rd stria mediad, to 9th laterad; the other, on posterior third, transverse, more or less round, lying between 2nd, 3rd or 4th stria and the 9th; (3) tarsi more or less rufous. Pubescence fine, short, whitish. Front flattened anteriorly; frontal margin obtusely subangulate at middle; punctation fine, fairly even. Antennae with 2nd segment small; 3rd similar to 4th and slightly shorter; 3rd to 10th subserrate; 11th slender, at least four times as long as wide; tip of 8th segment barely exceeding hind angle of prothorax in male (not quite attaining tip of hind angle in probable female).

Prothorax widest at about middle; about as long as wide; sides arcuate, slightly more sharply narrowed anteriorly than posteriorly; hind angles short, directed almost straight backward, without carina; position of basal sulci marked by long carina; punctation on dorsum, under moderate magnification, double, the larger round punctures evenly spaced with fine, smaller punctures between.

Scutellum flat, with slight rounded elevation on either side of middle; punctation fine.

Elytra across humeri wider than distance across hind angles of prothorax; sides narrowing to posterior three-fourths in male (to about middle in probable female), thence more rapidly to conjointly rounded apex; striae consisting of impressed round punctures; intervals convex basally, the 7th

interval markedly elevated posteriorly for part of the distance between hind margin of posterior maculation and apex of elytron.

Body beneath finely, sparsely and rather evenly punctate, with fine punctulations between. Tarsal claws simple. Length 3.0-3.6 mm.

U. S. N. M. No. 58273.

Described from a holotype male, Sir Graham Moore Island, West Australia, Feb. 20, 1945; twelve paratype males, same data, and, in addition, Anjo Peninsula, West Australia, Feb. 15; and two paratypes, thought to be females, Sir Graham Moore Island, Feb. 20.

In none of the descriptions of other Australian *Cardiophorus* is mention made of the prominent elevation toward the apex, of any of the elytral intervals; in this particular then, *elevatus* is unlike any other described Australian species except the following (*malkini*). As in several other species from the southern continent, the lateral margins of the prothorax are incomplete anteriorly. The lateral lobes of the aedeagus are simple, but widen shortly below the apex, at which point they become robust and (in ventral aspect) appear to be bipartite, with an apparent longitudinal suture.

Cardiophorus malkini n. sp. (Figure 2)

Rather robust, convex; moderately shiny. Black with following exceptions: (1) a luteous longitudinal vitta on each elytron, occupying five intervals and failing to attain the sutural and lateral margins, the anterior margin (by about the width of the vitta), and the apex (narrowly); (2) basal antennal segment sometimes dark reddish; and (3) tibiae and tarsi (sometimes the trochanters also) reddish brown.

Front convex; punctation finely double, the larger punctures shallowly umbilicate under moderate magnification. Antennae feebly serrate; exceeding hind angle of prothorax by about one segment (male) or slightly less (female); 2nd segment small; 3rd one and one-half times as long as 2nd, and about two-thirds as long as 4th; similar to 4th in shape, but narrower; segments 4-10 progressively lengthening; 11th subequal to 10th.

Prothorax slightly longer than wide; sides gently arcuate, more strongly narrowed anteriorly than posteriorly; hind angles short, directed straight backward, not carinate. Pronotum convex; punctation double, as on front; shallowly impressed medianly behind; notch of basal sulci inconspicuous, marked by long, anteriorly divergent sutures.

Elytra across base wider than distance across hind angles of prothorax; sides narrowed to beyond middle (male) or to about middle (female), thence more strongly to conjointly rounded apex. Striae with deep, round punctures; intervals convex, the 7th prominent apically, where it becomes almost carinate. Apical portion of elytron generally flat as far laterad as the elevated 7th interval; sharply declivous beyond.

Body beneath convex; punctation subumbilicate on thoracic sternites with fine punctulations between; finer, but similarly mixed punctation on abdominal sternites. Claws simple.

Length 2.6-3.0 mm.

U. S. N. M. No. 58274.

Described from a holotype male, an allotype female, and 16 paratypes, all from Sir Graham Moore Island, West Australia, February 20, 1945.

In color pattern this species appears unlike any other described Australian species. The elevated terminal portion of the 7th elytral interval should distinguish the species from all its Australian congeners except the preceding (*elevatus*). As in that species the lateral margins of the prothorax are incomplete. The lateral lobes of the aedeagus are simple and slender. I take pleasure in naming this species after its collector, Mr. Borys Malkin.

Platynychus papuensis (Candèze)

One specimen, Hollandia, Dutch New Guinea, April.

Neodiploconus aequalis (Candèze)

Two specimens, Hollandia, April.

Neodiploconus ruficollis (Schwarz)

One specimen, Hollandia, April.

Melanotus albertisi Candèze

Twenty-five specimens, Hollandia, April.

Hapatesus hirtellus Candèze

Sixteen specimens, Hollandia, April.

Neotrichophorus erubescens (Candèze)

One specimen, Hollandia, April.

Patricia genus novum

Convex; robust.

Head directed perpendicularly downward; front margined; labrum transverse. Mandibles prominent, falciform. Terminal segment of maxillary palpus vaguely truncate; that of labial palpus, spindle-shaped. Antennae long, 11-segmented, strongly serrate; 2nd segment minute; 11th subappendiculate.

Prothorax without trace of lateral carina; pleurosternal sutures fine, closed. Sides of mesosternal cavity precipitous and very narrow, usually concealed by the normal position of the mesocoxae.

Scutellum cordiform.

Elytra coarsely punctate.

Legs fossorial. Hind coxal plates strongly narrowed externally, the width across the basal third exceeding half the entire length of the plate. Mesocoxae well separated. Trochanters of hind legs greatly developed, those of fore and middle legs less so. Femora robust, particularly on hind legs. Tibiae flattened, dilated apically, especially on hind legs. Tarsi and claws simple.

This physodactyline genus most closely approaches, according to Schwarz's key (Genera Insectorum, fasc. 46 [Elateridae] : 310, 1907) the African *Margogastrius* Schwarz, but differs from it in having the antennae elongate, and the sides of the mesosternal cavity very narrow on the outer, visible portions, not flattened. *Patricia*, like *Antoligostethus* Blackburn, has the head directed perpendicularly downward; however, in *Patricia* the mesocoxae are not contiguous, and the sides of the prothorax are not margined.

Nullarborica Blackburn has the mesocoxae separated as in *Patricia,* but has the head directed obliquely forward, and has the sides of the prothorax margined.

The type of *Patricia* is *Patricia australica,* described below from Sir Graham Moore Island, West Australia, and from the nearby mainland of northwest Australia.

The three genera of the elaterid subfamily Physodactylinae now known from Australia may be separated by the following key:

A Sides of prothorax margined..B
  Sides of prothorax not margined ....**Patricia** gen. nov.
B Mesocoxae contiguous; head perpendicular....**Antoligostethus** Blackburn.
  Mesocoxae separated; head oblique......................**Nullarborica** Blackburn.

Patricia australica n. sp. (Figures 3 and 4)

Robust, shiny, convex; black, with mouthparts, coxae, tips of tibiae and the tarsi completely, dark rufous. Pubescence fine, long, semi-erect, ashy white; short and dense on scutellum.

Front nearly flat anteriorly, frontal margin arcuate; coarsely, evenly punctate. Antennae exceeding half the body length, tip of 8th segment slightly exceeding hind angle of prothorax; strongly serrate from 3rd segment; 2nd minute; 3rd triangular, as long as wide, subequal to 4th; 3rd to 10th progressively lengthening, 10th twice as long as wide; 11th five times as long as wide, subappendiculate on apical fifth.

Prothorax without lateral margin; about as long as wide; dorsum convex, sides precipitous, basal declivity abrupt, base widely flattened and nearly impunctate; elsewhere the dorsum has coarse, evenly spaced punctation with a few smaller punctures between. Sides evenly rounded from posterior two-thirds to anterior angles; hind angles short, produced nearly straight backward, not carinate.

Scutellum cordiform; conspicuously covered with dense, fine, white pubescence.

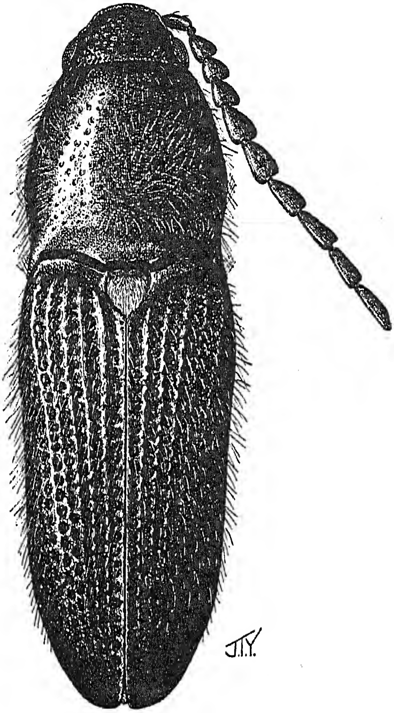
Elytra wider across base than distance across hind angles of prothorax; sides narrowed to posterior two-thirds, thence more rapidly to conjointly rounded apex; striae consisting of rows of coarse, round punctures which, on posterior third, obliterate all trace of interstrial intervals; toward the apex the strial punctures become fenestrate; interstrial intervals convex anteriorly.

Body beneath strongly convex; thickly covered with longer pubescence than above. Pleurosternal sutures fine, nearly straight. Mucro prominent between fore coxae, bent abruptly upward behind; mesosternal cavity inclined, its sides narrow, usually hidden by normal position of mesocoxae. Punctation on prosternum coarse, sparse; on abdominal sternites shallow, widely spaced with a few finer punctures between. Tibiae widened apically, particularly on posterior pair; anterior pair terminating in a broad, elongate spur. Tarsi simple, narrow, first segment on hind pair wider than succeeding ones. Claws simple.

Length 5.00-5.25 mm.; width about 2.0 mm.

U. S. N. M. No. 58275.

Described from a holotype male, Sir Graham Moore Island, West Australia, February 20, 1945; four paratypes (three males and one probable male), same data; and one probable male paratype, Anjo Peninsula, West Australia, February 15, 1945.



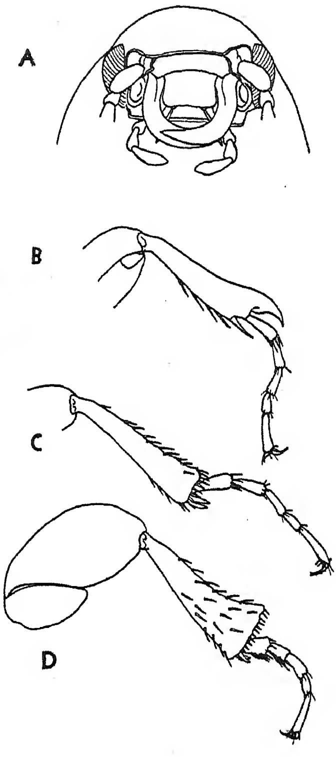


Figure 3 (left). *Patricia australica* genus et sp. nov.

Figure 4 (right). *Patricia australica* n. sp.
A. View of head; B. fore leg; C. middle leg; D. hind leg.

Notes on the Genus Thalassomyia Schiner, with Descriptions of Two New Species (Diptera: Tendipedidae)

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(Presented at the meeting of September 9, 1946)

Introduction.—The writer became interested in the marine genus *Thalassomyia* after collecting material at Hilo, Hawaii, which apparently represents a new species. Through the kindness of Dr. L. G. Saunders of the University of Saskatchewan additional material of *Thalassomyia* was received for study, including all stages of *T. frauenfeldi* from Italy and adults and pupae of what apparently is also an undescribed species from Hong Kong, China. Dr. F. X. Williams[1] of the Hawaiian Sugar Planters' Experiment Station kindly loaned a series of adults and a pupal skin of *Thalassomyia* from New Caledonia which proved to be identical with the Hong King material. Specimens of *Thalassomyia* from the Marquesas Islands in the Bernice P. Bishop Museum at Honolulu were studied through the courtesy of E. C. Zimmerman. It is therefore possible in the present paper to redescribe two of the known species, to describe as new two additional species, and to give notes on the larvae and pupae of *Thalassomyia*.

Historical.—The genus *Thalassomyia* was erected in 1856 by Schiner for the marine species *frauenfeldi* from Trieste. Chevrel in 1903 described *Scopelodromus isemerinus* from Brittany and gave notes on the larva. In 1904 Chevrel made *Scopelodromus* a synonym of *Thalassomyia,* but maintained that *frauenfeldi* and *isemerinus* were distinct species. The species of *Thalassomyia* from fresh-water streams described by Tomosvary (*congregata,* 1884), Johannsen (*obscura,* 1903; *fulva,* 1908), and Harnisch (*glabripennis,* 1924) have been referred to the genus *Cardiocladius* Kieffer (see Edwards, 1926; Thienenmann, 1932). Lynch-Arribalzaga's *Chironomus obscuripennis* (1894), described from a female collected under a stone on the seashore at Montevideo, Uruguay, was considered by Edwards (1931) to be a *Thalassomyia,* most likely *frauenfeldi,* as Edwards reported *frauenfeldi* twice from Montevideo, first in 1926 (p. 786), and again in 1931, (p. 304) the latter from females taken on his South American trip in 1926. The insects described by Santos-Abreu (1918) from the Canary Islands

[1] Grateful appreciation is extended to Dr. Williams, who has contributed much to the study of water-loving insects in Hawaii, and has been a constant source of help and inspiration to the writer.

as *Scopelodromus canariensis,* as well as Chevrel's *isemerinus,* were placed in synonymy with *T. frauenfeldi* by Edwards in 1926, and in 1929 Edwards also submerged Wollaston's *Chironomus pedestris* (1858) under *frauenfeldi.*

In the Pacific region, Johnson (1924) described a new genus and species, *Galapagomyia longipes,* from the Galapagos Islands. In 1926 Edwards pointed out that *longipes* was probably a *Thalassomyia* and described a new species, *T. africana,* from a male taken on the coast of Tanganyika. In 1928 Edwards described *T. pilipes* from Samoa, and in 1935 in recording *pilipes* from the Marquesas Islands, he stated that after examining specimens of *Thalassomyia* collected by Miss Cheesman in the Galapagos, he concluded that his *pilipes* was most probably identical with *longipes* (Johnson). At the same time he recorded *T. africana* from the Marquesas, including a description of the female.

In 1830 Johnston described *Campontia eruciformis* as an annelid worm, from between tidemarks, Berwick Bay, Northumberland, England. However, as reviewed by Bezzi (1913) and Edwards (1926), it was early agreed that *Campontia* was a marine insect larva, and Miall (in Theobold, 1892) suggested it to be *T. frauenfeldi.* Although Edwards (1926) refused to adopt the name *Campontia,* since in view of the discrepancies in Johnston's description and figure it could apply about equally well to several marine tendipedids, Townes (1945) has pressed the rule of oldest (valid) included genus in using the subfamily name *Campontiinae* for the established *Clunioninae.* If *Campontia* were to be adopted in the sense of *Clunioninae,* it would probably be applied to *Thalassomyia,* as *frauenfeldi* occurs in Britain.

Thalassomyia Schiner

Thalassomyia Schiner, Verh. Zool. bot. Ver., **6**: 218, 1856; Edwards, Ent. Mo. Mag., **60**: 204, 1924 (diagnosed and compared with *Cardiocladius*); Proc. Zool. Soc. Lond., **51**: 786, 1926 (diagnosis; syn.: *Scopelodromus, Galapagomyia*); Trans. R. Ent. Soc. Lond., **77**: 371, 1929 (diagnosis).

(?) *Campontia,* Johnston, Zool. Journ., **3**: 325, 1830 (as annelid worm).

Scopelodromus, Chevrel, Arch. Zool. Exp., **1**: 1, 1903.

Galapagomyia, Johnson, Zoologica, **5**: 86, 1924.

Adult.—Sexes similar, wings well-developed. Eyes round, not emarginate, bare. Antennae (fig. 4) alike in both sexes, 7-segmented, last segment (figs. 1, 2, 4) with a nipple-like terminal constriction, all segments with an encircling row of long bristles. Palpi (fig. 5) long, often longer than the antennae, 4-segmented, the two distal segments quite long and narrowed. Pronotum reduced, divided into lateral lobes which may be narrowly or widely separated. No trace of suture dividing anepisternite from the sternopleurite. Legs elongate, front coxa enlarged, femora somewhat thickened

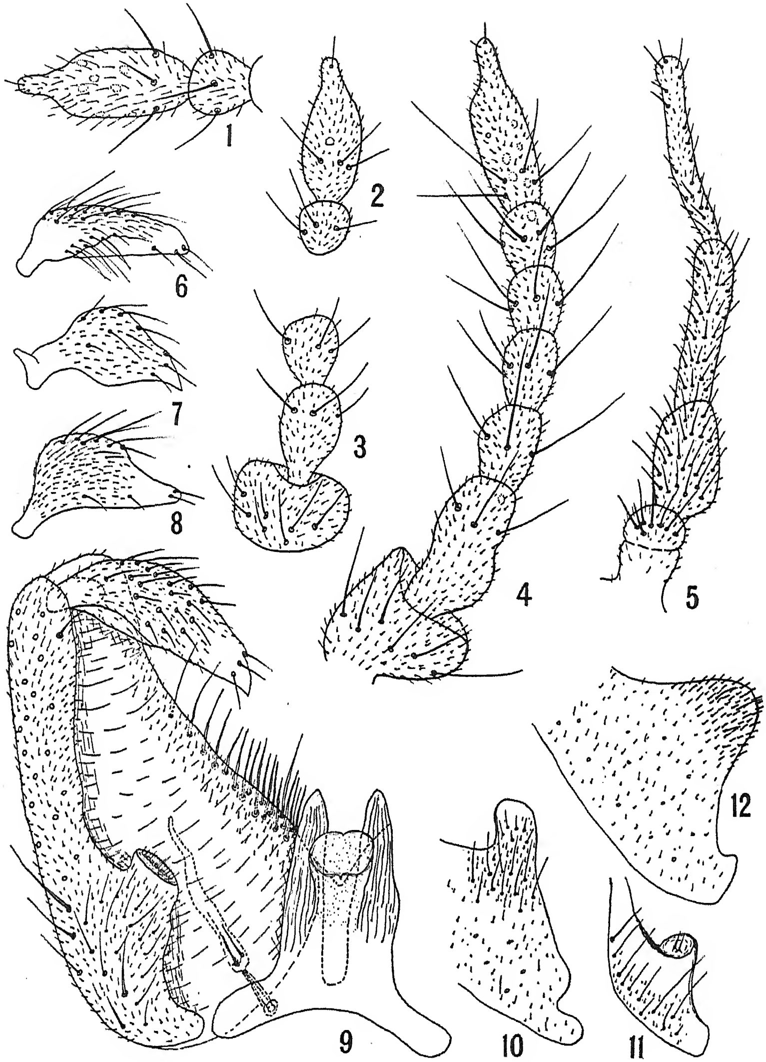

PLATE II

Figures 1-4, antennae. 1. *frauenfeldi.* 2, 3. *maritima.* 4. *setosipennis.* Figure 5, palpus, *setosipennis.* Figures 6-8, male dististyles. 6. *africana.* 7. *maritima.* 8. *frauenfeldi.* Figure 9, male genitalia of *setosipennis,* dorsal view, right gonostyle removed. Figures 10-12, dorsal lobes of basistyle. 10. *africana.* 11. *maritima.* 12. *frauenfeldi.*

toward base, tibial spurs well-developed, one on front legs, two on posterior pairs; third tarsal segment bilobed at tip; fourth segment short and strongly cordiform; fifth simple, not trilobed at tip; empodium very long, pectinately plumose; anterior claws of front and middle legs of male pectinate at tip, other claws of male and all claws of female sharp; pulvilli present as hyaline lanceolate lamellae. Wings with venation like *Tendipes*, R_{2+3} absent, R_1 short, r-m proximad of wing-middle, fCu at or slightly beyond base of r-m; squama fringed; wing entirely covered with microtrichiae, setae on costa and all of radial veins, in one species also on bases of remaining veins. Male genitalia (fig. 9) small, turned through 180° as in related groups, dorsal lobe (figs. 9-12) present on (primitively or morphologically) dorsal margin of basistyle (coxite), dististyles (styles) (figs. 6-9) infolded; female cerci (figs. 13-15) prominent, patch of long hairs (fig. 13) present on last abdominal sternite of female.

Larva.—Long, without conspicuous setae, head slightly longer than broad; antennae (fig. 17) small, 4-segmented; mandibles strongly sclerotized and dentate, mentum (fig. 19) broad, with median large pointed tooth and smaller lateral teeth. Anterior pseudopods short and fused on basal half, with many small hooks and spines distally and on lateral and posterior sides; posterior pseudopods short, not fused at base, with distal strong recurved hooks (figs. 20, 21).

Pupa.—Cephalothorax with antenna-cases prominent, projecting latero-ventrad; respiratory organs (figs. 22, 23) borne laterally, extending cephalad, horn-shaped with spiracle on basal third or narrow and cylindrical with sub-apical spiracle. Leg and wing-cases free but appressed to body. Abdomen not tapering, preapical segments without prominent appendages or spines, terminal segment (figs. 24-26) obliquely truncated, with a large flattened elliptical heavily-sclerotized dorso-posterior shield with emarginate dentated rim.

Key to Species of Thalassomyia

1. Wing veins M, Cu, and 1st A as well as costa and radius with setae; male dististyles not markedly swollen at base (fig. 9); female cerci slender (fig. 15)........ **setosipennis** sp. nov.
   Wing veins M, Cu, and 1st A without setae, only costa and radius setose 2
2. Male dististyles strongly bilobed at tip; legs of male with long hair (3 times diameter of leg); last abdominal sternite of female with patch of dark-colored hairs; general color almost black; fCu much beyond base of r-m........ **pilipes** Edwards
   Male dististyles simple at tip, not bilobed (figs. 6-9); hair on legs of male long or short; last abdominal sternite of female with patch of long yellowish hairs (fig. 13); general color light brown; fCu at or but slightly beyond base of r-m........ 3
3. Last antennal segment abruptly narrowed to terminal nipple (fig. 1); fCu at level of base of r-m; female cerci greatly and abruptly expanded at base (fig. 14); male dististyles swollen at base, snout-like, rounded at tip (fig. 8); hairs on male legs short as in female, length less than diameter of leg........ **frauenfeldi** Schiner
   Last antennal segment tapering to terminal nipple (fig. 2); fCu beyond base of r-m; female cerci slender, gradually tapering from base (figs. 13, 15); male dististyles slender or swollen at base, sharp or blunt at tip (figs. 6, 7, 9); hairs on male legs short or long 4

4. Male dististyles swollen at base, beaklike, sharply pointed and bare at tip (fig. 7); dorsal lobe of basistyle small, conical, with fine hairs in hollowed-out apex (fig. 11); hairs on male legs about twice as long as diameter of tibia; female cerci moderately slender on distal portion (fig. 13)..**maritima** sp. nov.
   Male dististyles slender, not swollen at base, tip bluntly pointed, bearing two setae at extreme apex; dorsal lobe of basistyle large, flattened, thumb-shaped, with bare apex but fine setae on sides (fig. 10); hairs on male legs variable, from one to three times the diameter of a tibia; female cerci very slender on distal portion..**africana** Edwards

(Note: **T. longipes** [Johnson] from the Galapagos Is. is not included in the above key, as the description is short and specimens were not available; it is probably close to **pilipes** or **setosipennis**).

1. Thalassomyia setosipennis sp. nov.

Adult.—Length of body, 2-3 mm.; wing, 2.1 mm.; breadth of wing, 0.9 mm.; general color light brown, anterior two-thirds of mesonotum between subdorsal setae, lateral vittae of mesonotum behind humeral depressions, postscutellum and sternum dark brown; pronotal lobes, wing bases, scutellum, and halteres yellowish-white; a jet black line on posterior side of mid coxa. Antennae (fig. 4) 7-segmented; basal segment about twice the diameter of distal segments, about two-thirds as long as broad; second segment elongate, about twice as long as broad, constricted in middle; segments three to six subspherical; seventh segment about three times as long as broad, with terminal fourth abruptly constricted and nipple-like; each segment with an encircling row of long bristles. Ratio of lengths of antennal segments beginning proximad 18:30:20:20:17:17:42. Palpi (fig. 5) 4-segmented, long, nearly twice the length of the antennae; basal two segments broad, about twice as long as wide, first segment with encircling row of large bristles, second entirely covered with large bristles; third and fourth segments narrowed and greatly elongate, each nearly twice the length of second segment, bristles on third segment strong and dense, on fourth segment fine and quite sparse; ratio of lengths of palpal segments beginning proximad 40:40:100:110. Paraglossae ovoid, bristly, about size and shape of second palpal segment. Clypeus and vertex evenly set with numerous strong bristles; vertex slightly darkened.

Pronotum narrowly divided medianly into lateral lobes, these very narrow and each bearing a line of about 15 long setae. Mesonotum large, roundly arched, somewhat flattened between wing-bases, with rows of long setae as follows: a median longitudinal row which divides about two-thirds the way back to form an irregular double row extending to scutellum; two sub-dorsal longitudinal rows from anterior margin to scutellum; an irregular linear patch on each lateral margin from humeral angle to wing-base, connected anteriorly by a transverse row at right angles to the subdorsal rows. Scutellum quite convex, about half again as wide as long, bearing about 20 long dark setae densest laterally; postscutellum about size of scutellum, flattened, darker in color and quite bare.

Wings covered with microtrichiae, appearing smoky grey-brown; costa and radial branches infuscated with light brown; costa, R, R_1, and R_{4+5} densely set with strong dark setae, base of M, Cu, and 1st A also setose; squama and posterior wing margin fringed with long hairs, these decreasing in size toward wing tip. R_1 enters costa at a little less than half the length of R_{4+5}; R_{2+3} absent; R_{4+5} curved, almost paralleling costa which it enters slightly before wing tip; M almost straight, slightly curved distally to meet wing margin slightly below the apex; Cu forks slightly beyond base of r-m, the fork very narrow basad; Cu_1 slightly curved to meet wing-margin halfway between tips

of M and Cu_2, Cu_2 also but gently curved; 1st A inconspicuous and does not reach wing-margin. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 5.5:5:10:4.5:12 respectively.

Legs long; relative lengths of segments from coxa distad, 3:1:9:11:6:2.5:1.4:0.5:1 on front legs, 2.5:1:13:12.5:5:2:1.2:0.4:1 on middle legs and 3.5:1:14:14:7:3.2:0.5:1 on hind legs. Femora slightly clavate basally, tibiae long, cylindrical, tarsal segments sub-cylindrical, except fourth segment cordate; last segment simple; empodium long, pectinately plumose; claws simple, the anterior claw on each front and middle leg of male pectinate at tip, posterior claws on all legs as well as anterior claw on hind legs of male and all claws of female sharp; pulvilli arise from base of each claw as a lanceolate hyaline lamella. Legs densely setigerous, most of these setae about as long as diameter of segment, but there are a few scattered heavy spines dorsally on each tibia about twice as long as the rest.

Abdomen moderately stout, all segments clothed with bristles, these stronger on anterior tergites, becoming finer caudad and on the sternites. Male genitalia (fig. 9) inverted, ventral surface thereby lying uppermost, broad; basistyles broad at base, about twice as long as broad at base, abruptly narrowing midway to the truncated apex; a flattened elliptical cup-like lobe near base on (morphologically) dorsal side, this lobe about half as high as broad, outer surface bare but the hollowed-out end with minute apparently glandular or sensory hairs; ventro-mesal margin of basistyle with dense patch of long hairs toward base. Dististyles folded inwards; proximal third somewhat enlarged, gradually tapering distally to a sharp point; proximal portion densely hairy, distal portion bare except for four or five sub-terminal setae. Aedeagus projecting dorso-caudad between bases of basistyles, consisting of a short dorsal hyaline penis lobe with bluntly rounding apical lips, flanked ventrolaterally by a pair of heavily sclerotized laminiform guard-plates with rather sharply rounded apices; anal opening by membranous protuberance on eighth tergite just anterior to aedeagus. Female abdomen stouter, downcurved, rounded distally; cerci (fig, 15) prominent, gradually tapering from rounded base to pointed downcurved tip; valves of ovipositor inconspicuous; all parts of female genitalia densely pilose; last abdominal sternite with a dense patch of long light-colored hairs, these over half the length of the cerci.

Larva.—Length mature, about 8 mm.; head capsule 0.6 mm. long by 0.4 mm. wide. Body whitish; head sclerotized light brown in color, blackish on cervical margin and distal portion of mandibles and mentum; hooks of pseudopods brownish black.

Head oval, roundly tapering anteriorly and down-curved toward labrum. Frons and clypeo-labrum not separated by a suture; the posterior portion of frons about twice as long as wide, widest at about middle, tapering caudad to a blunt point at junction of arms of epicranial suture; anterior portion constricted to about two-thirds of greatest width of frons, giving frons-clypeolabrum complex a spindle shaped appearance; integument of frons faintly reticulate. Clypeolabrum about as wide as long, widest caudad, tapering anteriorly to the blunt nose-like labrum; lateral margins with a distinct emarginate sclerotization which is broken and articulated at posterior third forming a distinct posterior clypealia and anterior torma, the latter being secondarily produced ventrad for the articulation of the premandibles; mesally the clypeolabrum is membranous, clypeal sclerites absent, but with prominent platelike integumental thickenings giving integument an "alligator-hide" appearance. Paired lateral setae arise from basal tubercles as follows: a pair near anterior margin of clypeolabrum; a second pair about half-way back; a third pair at posterior lateral extremity; a fourth pair just caudad of third at anterior constriction of frons; and a fifth pair just anterior to widest portion of frons. The vertex is also finely reticulate, with a seta-less tubercle on each side along frontal suture just posterior to fifth frontal setae mentioned above, and a fine seta on each side about midway between this tubercle and junction of frontal sutures. The small antennae are borne laterally at level

of the frontal-clypeal junction, consisting of a stout barrel-shaped proximal segment slightly longer than wide and about twice as long as distal segments combined, bearing distally three minute progressively smaller distal segments and an adjacent membranous biramous Lauterborn's organ as long as these combined. Lateral margin of head bears two fine setae on each side just behind bases of mandibles and a ventrolateral pair just behind lateral corners of mentum; ventral surface of head capsule with the integumental reticulations rather prominently pebble-grained. A small irregular eye-spot is faintly indicated on each side just caudad of base of mandibles.

Cephalic margin of labrum with several pairs of very fine setae mesally and a pair of sublateral tufts of flattened feathered hairs; just below on overhanging ventral margin are a median patch of minute blunt spines and tubercles and a prominent lateral tuft of flattened feathered hairs. The paired premandibles are articulated basally to a ventral projection of the tormae, each forming a heavily sclerotized appendage about twice as long as broad with broad flattened lobe-like apex bearing a closely appressed hyaline distally-frayed veil. Mandibles stout, with five or six stout blackened teeth on distal third, a compact brustia of about ten long laterally-fringed hairs near base of dorsal side and ventro-lateral margin bears two long setae. Maxillae simple, a large triangular dorso-basal sclerite bears two long setae; an ovate ventral sclerite bears a distal membrane with a ventral beard of small flattened hairs, long setae, and several small blunt spines; a small unsegmented palpus about as broad as long with several minute sensillae on the truncated membranous apex is borne about midway of distal margin of maxilla, two slender setae arise from maxilla near base of palpus; dorsal margin of maxilla membranous and fringed with flattened amber hairs. Hypopharynx consists of a small median oval transverse membranous lobe bearing a dense beard of curved flattened hairs supported by two slender sclerotized arms in a V-shaped bridge, the arms of the V connected by a fine membrane bearing very fine hairs. Mentum triangular in outline, the median tooth triangular with pointed apex, five or six smaller progressively much shorter teeth on each side.

Anterior pseudopod shallowly bilobed, each lobe bearing a crown of spines of posterior side ranging in size from minute recurved spicules well up on side of lobe to long slender slightly curved hooks at apex. Integument of thorax and eight preapical abdominal segments bare, without discernible setae. Ninth segment of abdomen rounding dorso-posteriorly and bearing ventrally a pair of stout tapering pseudopods each slightly longer than broad and bearing an apical posteriorly interrupted crown of 14-15 simple rather slender and strongly recurved hooks. A pair of long fine sublateral hairs on posterior extremity of ninth segment, and each posterior pseudopod bears 4-5 minute black hairs on posterior and lateral sides. Anal gills absent.

Pupa.—Length about 5 mm. Integument of cephalothorax and terminal abdominal disc with pebble-grained sclerotized thickening; preapical abdominal segments transparent except for narrow U-shaped sclerotized lines along basal and lateral margins of tergites and sternites, small shagreened patches at apices of each lateral sclerotized line, third sternite with a prominent broad median longitudinal amber-colored area of blunt raised tubercles. Cephalic region set off as a broadly rounded emarginate anterior lobe, the antenna cases arising laterally as two latero-posteriorly projecting horns, a long hair arising just mesad of each horn. Thorax arched dorso-anteriorly, a prominent slender respiratory organ projecting forward, upward, and laterally from each humeral corner; these organs quite slender and elongate, about six to eight times as long as wide, the apex rounded with the spiracle located dorsally at the apex; tracheal trunk nearly as large as lobe except at distal fifth which is greatly constricted; spiracle with lip radially segmented into about ten divisions. Two long hairs arise just cephalad of base of each respiratory organ; two or three submedian pairs of fine hairs along midline of dorsum, and two sublateral pairs anterior to bases of wing-cases. Wing-

and leg-cases project caudad to about level of third abdominal segment, free from but closely appressed to lateral and ventral surface of body. Abdominal segments slightly wider than long, slightly tapering from segments I to VII, without evident setae. Terminal segment obliquely truncate forming a dorso-posteriorly flattened emarginate elliptical shield or disc. Face of this disc divided at upper sixth by a dorsally-arched transverse suture; portion above the suture almost perpendicular to body axis, forming an angle with the posterior portion of the disc. Rim of anterior portion with heavily sclerotized denticles without hairs; rim of posterior portion with denticles fused in groups of one to five, bearing long amber hairs except at posterior extremity which is divided into two bare rounded lobes each with a strong apical ventrally-curved spike. Face of disc with extremely coarse pebble-grained sclerotizations; two long black hairs are placed laterally in a trapezoid on posterior sclerite. The trunk of the eighth segment anterior to the disc is not sclerotized but bears long dark hairs as follows: a subdorsal pair at rim of disc, two pairs on each side near ends of transverse suture of disc, and a pair about halfway back near rim of posterior sclerite of disc. The adult gonostyles are enclosed in a pair of prominent lobes of posterior margin of eighth sternite appressed to ventral surface of disc; in the male these are broadly rounding but in the female are longer and much narrower.

Holotype: Male, Hilo, Hawaii, March 2, 1946, W. W. Wirth (on rocks on beach) (pinned).

Allotype: Female, Hilo, Hawaii, December 4, 1945, W. W. Wirth (light trap near beach) (slide mount).

Paratypes: 20 males, 5 females, Hilo, Hawaii, December, 1945-January, 1946, (light trap); 2 males, 1 female, Hilo, Hawaii, February 27, 1946, W. W. Wirth (scampering over large boulders on bay shore in company with *Telmatogeton* spp. and *Clunio* sp.); 1 male, 6 females, Kilauea, Kauai, September 8, 1946, W. W. Wirth (on boulders on beach, Kilauea Bay); 30 males, 17 females, Nawiliwili Bay, Kauai, September 9, 1946, W. W. Wirth (on rocks in bay); 3 males, 2 females, Nawiliwili· Kauai, September 8, 1946, W. W. Wirth (at light).

The types are deposited in the U. S. National Museum; paratypes are in the collections of the Bernice P. Bishop Museum, the California Academy of Sciences, and of the author.

Many larvae and pupal exuviae were found floating in eddies around wave-washed rocks in Nawiliwili Bay, Kauai. All hand collections of *T. setosipennis* at Hilo, Hawaii, and at Kilauea and Nawiliwili, Kauai, were from inter-tidal rocks along the shores of shallow bays receiving considerable fresh-water from stream outlets. Heavy growths of the algae *Ulva* sp. and *Enteromorpha* sp. were present on these rocks in each case, indicating perhaps that *Thalassomyia* prefers water of less salinity than sea-water. However these insects are also probably quite dependent upon the tidal rhythm as are other marine insects, and upon wave action, hence their habitat is restricted to open shores near stream outlets.

The adults of *T. setosipennis* are quite active, hard to catch, much more inclined to flight, and stronger fliers than *Telmatogeton* and *Clunio*. *T. setosipennis* is most active at night, as indicated

by the numbers caught in the light trap at Hilo, Hawaii, and at light at Nawiliwili, Kauai. Moreover, the adults taken during the day were encountered most frequently in the dark shaded crevices under the edges of rocks and boulders on the shore; when disturbed the adults seemed to seek even darker retreats, avoiding the sunlight whenever possible.

The most useful characters of *T. setosipennis* can be briefly summarized as follows: color light brown; head densely setose; antenna with second segment constricted in middle, last segment abruptly constricted to nipple-like tip; pronotal lobes narrow, closely approximated mesad; long hairs on legs of male about twice the diameter of leg; abdomen with dense, large setae; male dististyles not greatly swollen at base, sharp-pointed at apex; dorsal lobe of basistyle broad and flattened elliptical in cross-section, hollowed-out and with fine hairs at tip; female cerci slender and gradually tapering; hair patch on last abdominal sternite of female with long light-colored hairs, these not flattened. The respiratory horn of the pupa is almost identical in shape and structure with that of *T. maritima* described and figured below (fig. 23); the terminal shield is also quite similar to that of *maritima,* but the shagreening of the preapical segments is quite distinctive.

2. **Thalassomyia pilipes** Edwards.

Thalassomyia pilipes Edwards, Ins. of Samoa, pt. **6**, fasc. 2: 60, 1928 (Samoa; male, female); B. P. Bishop Mus. Bull. **114**: 87, 1935 (Marquesas Is.; male; prob. same as *longipes* [Johnson]).

Edwards (1935) recorded one male of *Thalassomyia pilipes* and three males and four females of *T. africana* from the Marquesas Islands. The male of *pilipes* and two females and one male of *africana* determined by Edwards and deposited in the B. P. Bishop Museum were examined by the writer, and genitalia mounts were made of the males. Although the male determined by Edwards as *pilipes* possessed long hairs on the legs (three times the diameter of the leg), it agreed in all other respects with the specimens of *africana.* The dististyles of this male with long hairs on the legs are not bilobed at the tip, the dorsal lobe of the basistyle is large and thumb-shaped, and in all other characters of the male genitalia it is evident that the Marquesas material represents one species which is here referred to *T. africana.*

The important characters of *pilipes,* as paraphrased from Edwards (1928) are: 1) color dark, body almost black; 2) male genitalia with bristles on ventral side of basistyle short, flattened and scale-like, also a number of similar bristles present on inner surface of basistyle near the base; 3) dististyles strongly bilobed at tip, additional lobe being developed on inner (flexor) surface; 4) cerci of female slightly and evenly widened towards base; 5) legs of male (but not of female) with rather long erect hair, which

is especially noticeable on the hind femora and tibiae, the hairs about three times as long as diameter of legs; 6) cubital fork short, its base much beyond level of base of R_{4+5}; 7) wing length about 3.5 mm.

3. **Thalassomyia frauenfeldi** Schiner.

Thalassomyia frauenfeldi, Schiner, Verh. Zool. bot. Ver. **6**: 218, 1856 (female; Trieste); Theobald, An Account of British Flies, 202, 1892 (note by Swainson on occurrence in Britain, larva marine); Miall on *Campontia* (=*T. frauenfeldi*); Edwards, Ent. Mo. mag., **10**: 204, 1924 (male described; Dalmatia; Suffolk); Proc. Zool. Soc. Lond., **51**: 786, 1926 (syn.: *Scopelodromus isemerinus* Chevrel, *S. canariensis* Santos-Abreu; recorded from Montevideo, Uruguay); Trans. R. Ent. Soc. Lond., **77**: 371, 1929 (? new syn.: *Chironomus pedestris* Wollaston; 4 British locality records); Dipt. Pat. & S. Chile, pt. 2, fasc. 5: 304, 1931 (Montevideo; ? syn.: *Chironomus obscuripennis* Lynch-Arribalzaga); Goetghebuer, Faune de France, **23**: 143, 1932 (short description of adult, larva, pupa; male genitalia, wing figured).

Thalassomyia frauenfeldi, var. *luteipes,* Strobl, Wien. Ent. Zeit., **19**: 173, 1900 (Algeciras, Spain).

Scopelodromus isemerinus, Chevrel, Arch. Zool. Exp., **1**: 1, 1903 (Brittany; larva and adult).

Thalassomyia isemerinus, Chevrel, Arch. Zool. Exp., **2**: 29, 1904 (from *Scopelodromus*); Johannsen, Cornell Agr. Exp. Sta. Mem. **205**: 36, 1937 (brief diagnosis of larva in table).

Scopelodromus canariensis, Santos-Abreu, Mem. R. Acad. Barcelona, **14**: 167, 1918 (Canary Islands).

(?) *Chironomus pedestris* Wollaston, Ann. Mag. Nat. Hist. [3] **1**: 114, 1858 (I. Madeira).

(?) *Chironomus obscuripennis* Lynch-Arribalzaga, Bol. Acad. Nac. Cordoba, **13**: 243, 1894 (Montevideo, Uruguay).

Adult.—Length of body, 3-5 mm.; wing, 2.7 mm.; breadth of wing, 1 mm.; this description made from old alcoholic material, so coloration is obscure, though apparently mostly light brown. Antenna (fig. 1) 7-segmented, the first segment large and sub-spherical, about twice the diameter of distal segments; second segment about twice as long as broad distally, constricted slightly beyond the middle; segments three to six subspherical, seventh segment a little more than twice as long as broad, with terminal fourth abruptly narrowed to a distinct nipple-like tip; first segment with many large bristles, distal segments each encircled with a row of long bristles, those of second on distal portion and of seventh on proximal portion. Ratio of lengths of antennal segments beginning proximad, 30:30:18:15:15:15:35. Palpi 4-segmented; as long as antennae, first two segments enlarged, first twice as long as wide, with long spines distad, second subspherical, covered with many long spines, third and fourth elongate, cylindrical, each markedly smaller in diameter than the preceding and less hairy, fourth almost bare; ratio of lengths of palpal segments beginning proximad,

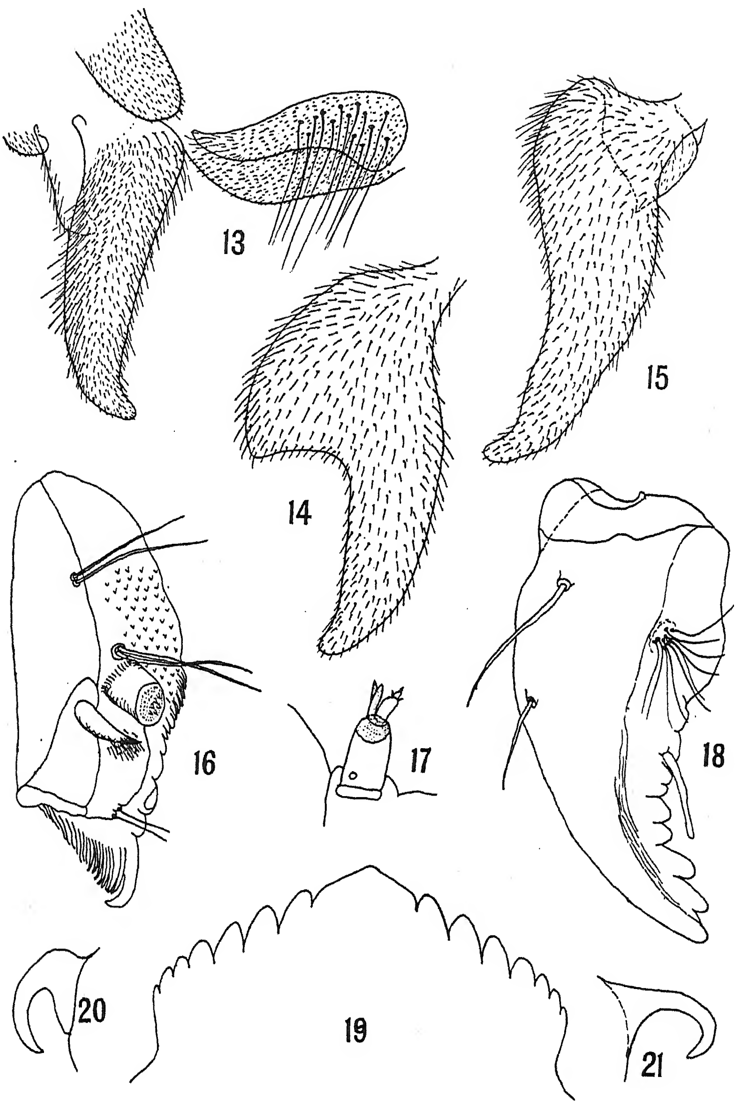

PLATE III

Figures 13-15, cerci of female. 13. *maritima* (also showing hairs on last sternite). 14. *frauenfeldi*. 15. *maritima*. Figures 16-21, larva of *frauenfeldi*. 16. maxilla, ventral view. 17. antenna. 18. mandible, dorsal view. 19. mentum. 20-21. hooks of posterior pseudopod.

30:25:50:60. Paraglossae bulbous, a little larger than second palpal segment. Clypeus and vertex with many stout bristles, those of clypeus somewhat longer and denser.

Pronotum widely divided into small lateral lobes; these each with about 8-10 long setae. Mesonotum roundly arched, with rows of long setae as follows: a median longitudinal row which divides about two-thirds the way back to form an irregularly double row extending to the scutellum; two subdorsal longitudinal rows from anterior margin to the scutellum; an irregularly linear patch which stair-steps twice in extending from the wing-base to meet the subdorsal row above the humeral angle. Scutellum quite convex, transverse, with 30-40 long dark bristles. Postscutellum nearly as long as broad, flattened and bare.

Wings covered with microtrichiae, appearing light smoky gray; subcosta and radial veins infuscated with light brown; costa and radial veins with numerous small sharp setae, other veins bare; squama and posterior wing margin fringed with long hairs, those of the latter becoming smaller toward wing-tip. R_1 enters the costa at about half the length of R_{4+5}, R_{2+3} absent; R_{4+5} curved parallel to costa to meet it just before wing tip; M nearly straight, reaching wing-margin slightly below the apex; Cu forks well beyond base of r-m, Cu_1 slightly curved to reach the wing-margin at a 45° angle halfway between tips of M and Cu_2; the latter curves rather more than Cu_1 to meet the wing-margin at about a 75° angle; 1st A scarcely discernible. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 7.5:7:13:6:15 respectively.

Legs long, slender, relative lengths of segments from coxa distad, 3.5:1.5:12:14:8:3.4:2:0.6:1.5 on front legs; 2.5:1:18:15:7:2.5:1.8:0.6:1.5 on middle legs, and 3.4:1:17:18:9:4.5:2.2:0.6:1.5 on hind legs. Femora slightly clavate basally; tibiae slender, subcylindrical; tarsal segments one to three subcylindrical, long and slender, fourth segment very short, as wide as long, cordate; fifth segment slender and simple. Tarsal claws simple, the anterior claws on front and middle legs of male pectinate at tip, other claws of male and all claws of female sharp; empodium long and pectinately plumose; pulvilli arise from base of each claw as slender hyaline lanceolate lamellae. Legs densely covered with fine setae, length of these not more than diameter of tibia.

Abdomen moderately stout, densely covered with long hairs on tergites, and with sparse inconspicuous setae on sternites. Male genitalia turned through 180°; basistyles broad at base, rounded laterally, abruptly narrowed on distal half; dorso-lateral margin expanded at base and bearing a flattened broadly-rounded setigerous lobe (fig. 12); with a patch of very long bristles on ventral side at base. Dististyles (fig. 8) folded inwards, snout-shaped, broadly expanded on basal two-thirds, narrowed distad, with apex rounded. Aedeagus with short rounded median lobe flanked by a pair of saber-shaped hyaline lateral plates about twice as long. Membranous anal lobe projecting dorsad just anterior to aedeagus well developed. Female abdomen stouter than male, not markedly curved, tapering strongly at genital segments. Cerci (fig. 14) broad at base with broad ventral tooth or lobe, suddenly constricted halfway, distal portion narrow, downcurved to a sharp apex. Genital segments densely pubescent, patch of long hairs on last sternite light-colored.

Larva.—Length mature, about 10 mm.; head capsule 0.7 mm. long by 0.55 mm. wide. Body semi-hyaline, head heavily sclerotized and dark brown in color, almost black on cervical margin and apices of mandibular and labial teeth. Head oval, slightly tapering to anterior, ovoid in cross-section, curving, dorsally convex. Frons very long, ovoid, about twice as long as broad; broadest at anterior third, distinctly narrowed posteriorly to a rounding point at the junction of the arms of the epicranial suture at about one-fourth way from cervical margin; curving anteriorly to base of clypeus which it touches in an antero-curved suture about half as long as greatest width of irons; two

pairs of small hairs on lateral borders of frons, one near clypeal suture, the second about one-third way back; a pair of small hairs on head near epicranial suture just laterad of the posterior frontal hair, a second pair posterior to these by distance equal to that separating the anterior and posterior frontal hairs, a third pair just below each eye-spot, and a fourth pair anterior to the third at level of fronto-clypeal suture. Antennae (fig. 17) borne laterally at level of fronto-clypeal suture; small, four-segmented, the proximal segment stout and barrel-shaped, bearing a membranous biramous Lauterborn's organ adjacent to and as long as the three distal antennal segments; second segment peg-like, the third and fourth segments minute, forming a sharp point; second segment also bears some minute spines apically. A small irregular shaped eye-spot on each side of head just behind base of mandibles. Clypeo-labrum transverse, about twice as wide as long from dorsal aspect, apparently clypeus and labrum are fused together, lateral margins roundly emarginate and very heavily sclerotized; anterior margin folded ventrad in a straight line and continued ventro-caudad in a prominent overhanging lip; a pair of widely spaced sub-lateral hairs dorsally near the anterior margin; the concave under-surface of the lip bears a number of stout spines, feathery hairs and a median brush. Posterior to these on the ventral side is a transverse heavily sclerotized bridge to the lateral ends of which the premandibles are articulated, and which bears between these an assortment of small feathery spines and brushes. The premandibles are about twice as long as wide, proximal portion heavily sclerotized, distal portion broadly expanded into a thin hyaline apically-rounded incompletely two-lobed plate appressed to which is a membranous distally-pectinate brush or veil. The mandibles (fig. 18) bear seven heavily sclerotized teeth, the distal teeth stronger; just basad of the proximal tooth is a strong appressed hyaline distally directed spine, and a compact brustia of about ten long slightly frayed hairs is borne about midway on mesal margin; the convex surface bears two long setae. The maxillae (fig. 16) are comparatively flattened and membranous, bearing an assortment of flattened spines, pegs, spicules, setae, and platelets distally; maxillary palpi one-segmented, bearing about eight minute sensillae on the distal membrane. Hypopharynx membranous, supported by a very slender inverted U-shaped sclerite, the space within the "U" densely set with long fine hairs, and the semicircular membranous lip distad of the base of the "U" with close-set heavy curved-tipped spines. Mentum (fig. 19) wide, with 15 teeth, the median tooth broad, rather broadly pointed in the middle, the lateral teeth progressively shorter and smaller laterad.

Anterior pseudopods fused together proximad, separated only on distal half; at tip and extending about one-third way up on lateral and caudal sides with numerous spines ranging in size and shape from very long almost straight spines on anterior and mesal margin of distal extremity, progressively shorter and more curved until these spines are recurved hooklets well up on the posterior and lateral sides of the pseudopod. Hairs of the thorax and abdominal segments quite inconspicuous or absent. Thoracic and abdominal segments quite cylindrical, only slightly tapering toward caudal segments; leg buds show through integument on thoracic segments; abdomen nine-segmented, ninth segment tapering and rounded dorso-posteriorly and bearing the posterior pseudopods ventrally. A pair of blunt anal lobes project ventrad just posterior and adjacent to the posterior pseudopods, anal gills rudimentary. A pair of long hairs sub-laterally placed on caudal extremity of ninth segment, apparently not arising from a tubercle; there are a few other hairs scattered on ninth segment and on the pseudopods but they are very small and inconspicuous and often absent. Hooks of posterior pseudopods about 15 on each leg, in a triple row with a gap free from hooks about one-fifth of circumference on caudo-mesal side; individual hook (figs. 20, 21) heavily sclerotized dark-brown; broad basally and strongly recurving to a single sharp point.

Pupa.—Length, about 5-6 mm.; stout; exuviae with pebble-grained integumental sclerotization in region of cephalothorax and terminal abdominal disc; preapical abdominal segments transparent except for narrow U-shaped sclerotized lines along basal and lateral borders of tergites and sternites, these segments shagreened, especially adjacent to these lines, third sternite with a very heavily shagreened patch. Cephalic region set off from thorax as an emarginate anterior lobe, the antenna-cases arising laterally as two horns projecting latero-posteriorly over the pronotal lobes, a long hair arises just mesad of the base of each antenna. Thorax arched antero-dorsally, a prominent forward-projecting horn-shaped respiratory organ (fig. 22) arising from each humeral corner; spiracular opening located dorsally near outer margin at widest point of lobe, which is about one-third way from base; two long hairs on each side of mesonotum mesad of respiratory organ, and a single hair just anterior to and mesad of each wing base. Scutellum evident only as rounded arched posterior portion of cephalothorax. Wing and leg cases projecting posteriorad, closely appressed to ventral surface of body, halteres not evident. Abdominal segments slightly decreasing in width progressively from segments I to VII; these without hairs or bristles. Terminal segment (fig. 26) obliquely truncate, forming an oblique dorso-posterior flattened emarginate elliptical shield. Face of this shield divided at upper fourth by a dorsally arched transverse suture; rim of portion above this suture with heavily sclerotized denticles, rim of posterior portion of shield with denticles in groups of two to four bearing fine long amber hairs; these absent on postero-ventral margin which terminates in two rounded bare lobes each with a strong apical ventrally curved spike or hook. In the male pupa there are two pairs of long black setae placed sublaterally in a trapezoid on the caudal sclerite of the shield; in the female there is but one pair of sublateral hairs on this sclerite; upper sclerite without setae. The trunk of the eighth segment anterior to the shield is not sclerotized, but bears long black hairs as follows: a dorso-lateral pair, two on each side just below ends of the transverse suture, two pairs in like position just below ends of suture, a ventro-lateral pair about two-thirds the way caudad on posterior ventral margin of unmodified portion of eighth segment. In the male pupa the gonostyles are evident as two large appressed ventral lobes, while in the female pupa there are in the same region two small anterior lobes and two larger posterior lobes containing the developing ovipositor and cerci of the imago.

The above descriptions of *T. frauenfeldi* are based on alcoholic specimens kindly furnished by Dr. L. G. Saunders, collected at San Remo, Italy, May 23, 1928; 2 males, 2 females, 8 larvae, and 1 male and 1 female pupae were examined.

Johannsen (1937) includes a brief diagnosis of the larva of "(*Scopelodromus*) *Thalassomyia isemerinus* (Chevrel)" in a key, in which there are several discrepancies with the present material. It might be well to point out that in the present material the claws of the posterior pseudopods have a single point, rather than "one, two, or three" points, as Johannsen (and also Chevrel, 1904) states; the proximal corner of the base of the claw is quite easily mistaken for a second tooth, but on close examination it can be seen that the claw is fused to the leg at this point. In the present material there was but a single irregular eyespot on each side of the head, rather than "two distinctly separated, but unequal eyespots on each side of head," this character is probably variable. The mentum possesses fifteen teeth, rather than "thirteen," but the lateral teeth were small and could have been overlooked or the number may be vari-

able; the middle tooth is roundly pointed apically as in related genera, rather than "with an apical notch." The dorsal "preanal papillae" are rudimentary, there being but a pair of single hairs in the corresponding position, rather than "a tuft of bristles." A further comparison of larvae from the Atlantic coast of Europe should be made with Mediterranean larvae in order to clarify Chevrel's larval description.

The pupa of *Thalassomyia* resembles that of *Telmatogeton* quite closely in general aspect and in the shape and structure of the terminal shield of the abdomen; in *frauenfeldi* the respiratory organs are also like those of *Telmatogeton*, but in *maritima* these organs are quite remarkably different, being long and cylindrical, with the spiracle subapically located. Goetghebuer's (1932, p. 143) description of the pupa of *frauenfeldi* is too short to be of much use—"Nymphe—L. 4-5.5 mm. Le segment anal est court et formé de deux lobes, qui portent chacun une soie apicale." Furthermore his description of the larva differs in several respects from the present material—". . . le labium est composé d'une rangée de 14 dents, dont 2 médianes, plus longues que les latérales . . . les mandibules sont pourvues de 5 dents; les pseudopodes postérieurs sont courts et présentent 8-10 crochets bifides . . . ."

4. **Thalassomyia maritima** sp. nov.

Adult.—Length of body, 2 mm.; wing, 2 mm.; breadth of wing, 0.6 mm.; color light fuscous brown, without conspicuous markings. Antenna (figs. 2, 3) 7-segmented; basal segment (fig. 3) about twice the diameter of distal segments, about one-fourth wider than long; second segment (fig. 3) about twice as long as wide; tapering at base but not constricted in middle; segments three to six subspherical; seventh segment (fig. 2) about two and a half times as long as broad, tapering on distal half to a rather long nipple-like constricted tip; basal segment with scattered long bristles, segments two to seven each with an encircling row of long bristles, those of second at distal end and those of seventh at proximal end; all segments also pubescent. Ratio of length of antennal segments beginning proximad 20:20:12:12:12:12:32. Palpi 4-segmented, elongate, about as long as antennae; first segment about half again as long as broad, constricted in middle, distal part with four or five long bristles; second segment ovoid, about half again as long as broad, with scattered long bristles, third and fourth segments each about two-thirds as wide as the preceding and greatly elongate, and with bristles reduced; ratio of length of palpal segments, beginning proximad, 20:22:45:60. Paraglossae ovoid, bristly, clypeus and vertex with scattered bristles, these much sparser than in *frauenfeldi* and *africana*, there being only about 20-25 bristles on the clypeus and 30-40 on the vertex; median third of vertex entirely bare.

Pronotum widely divided medianly into lateral lobes, these quite narrow and each bearing 5-7 long setae. Mesonotum full and arched anteriorly, somewhat narrowed and longitudinally ridged between wing-bases, with longitudinal rows of long setae arising from light-colored ocellate spots as follows: a median row from anterior margin becoming an irregularly double row extending to the scutellum (15-20 setae), two subdorsal rows not quite reaching either the anterior margin or the scutellum (14 setae each), and two irregular lateral rows from near humeral area to above the wing-bases (12-13 setae each). Scutellum very convex, about half again as wide as long, with about 10 long dark setae. Postscutellum flattened, about as wide as long, bare.

Wings covered with microtrichiae, appearing smoky grey brown; costa and radial veins infuscated with light brown; costa densely setose, about 25 fine small setae on radial veins, most of these on R and R_1, other veins bare; squama fringed with about 5-10 fine hairs, posterior wing margin fringed with alternating long and short very fine hairs, these decreasing in length toward wing-tip. R_1 enters the costa at about a third the length of R_{4+5}; R_{2+3} absent; R_{4+5} curved almost parallel to costa which it enters just before wing-tip; M almost straight, slightly curving distad to enter margin of wing just below tip; Cu forks just beyond base of r-m, the fork very narrow basad; Cu_1 very slightly curved, Cu_2 curved toward tip; Cu_1 reaches wing margin halfway between the tips of M and Cu_2; 1st A inconspicuous. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 7:4:12:6:13 respectively.

Legs long, relative lengths of segments from coxa distad, 2.5:1:6.5:7.5:4:1.6:1:0.4:1 on front legs, 2.5:0.8:9.5:8.5:3.5:1.3:1:0.4:1 on middle legs, and 3:0.8:11:11:5.7:2.6:1.5:0.4:1 on hind legs. Femora slightly clavate basally, tibiae long, slender, cylindrical; tarsal segments subcylindrical except fourth segment cordate, last segment simple; empodium long, pectinately plumose; claws simple, the anterior claw on each front and middle leg of male pectinate at tip, other claws of male and all claws of female sharp; pulvilli arise at base of each claw as a lanceolate hyaline lamella. Legs densely setigerous, in the female these setae are nearly all short, about half the diameter of a tibial segment, but in the male, especially on the hind legs, most of the setae are longer, from one to two times the diameter of a tibia.

Abdomen moderately slender, rather sparsely covered with fine setae, these but slightly larger on the tergites and not markedly reduced caudad; the setae of the female abdomen particularly short. Male genitalia turned through 180°, small, slightly broader than long. Basistyles broad at base, narrowed on distal half, basad at the dorsal margin with a small conical lobe (fig. 11) bearing a few very fine sensory or glandular hairs in the hollowed-out apex; ventrally with the entire mesal margin set with long stout bristles; about eight similar bristles on inner surface near the base. Dististyles (fig. 7) folded inwards, much swollen at basal third, tapering beak-like to a sharp apical point; with numerous long setae and fine hairs. Aedeagus projects dorso-caudad between the bases of the basistyles, consisting of a short dorsal hyaline penis lobe with rounded apical lips, and a pair of straight laminiform rather sharp-pointed guard plates laterad and ventrad of the former; internal parameres prominent. Anal lobe membranous, finely setigerous, located on the dorsum just anterior to the aedeagus. Tip of female abdomen rather bluntly rounded, cerci (fig. 13) conspicuous, slender, tapering gradually from base, down-curved at tip; entire female genitalia densely pubescent; patch of hairs on last abdominal sternite light-colored, not as long as in *frauenfeldi* and *africana*.

Male pupa.—Length, about 3-4 mm; exuviae with pebble-grained integumental thickening in region of cephalothorax and terminal abdominal shield; preapical abdominal segments transparent except for very narrow sclerotized lines along basal and lateral margins, segments I-VII shagreened, more heavily so in transverse subapical patches on each tergite and sternite. Cephalic region set off from thorax as an emarginate antero-ventral lobe; the antennal cases prominent, arising laterally as two horns projecting latero-posteriorly over the pronotal lobes, not markedly tapering and with blunt obliquely truncated apex; a long dorsal seta arises just mesad of the base of each antenna. Thorax arched antero-dorsally; a prominent antero-laterally projecting cylindrical respiratory organ (fig. 23) arising from each humeral angle; this organ very elongate, about six times as long as wide, not tapering but rounded apically, spiracle located less than its diameter from the apex, tracheal trunk cylindrical and about half the diameter of the lobe, with slight

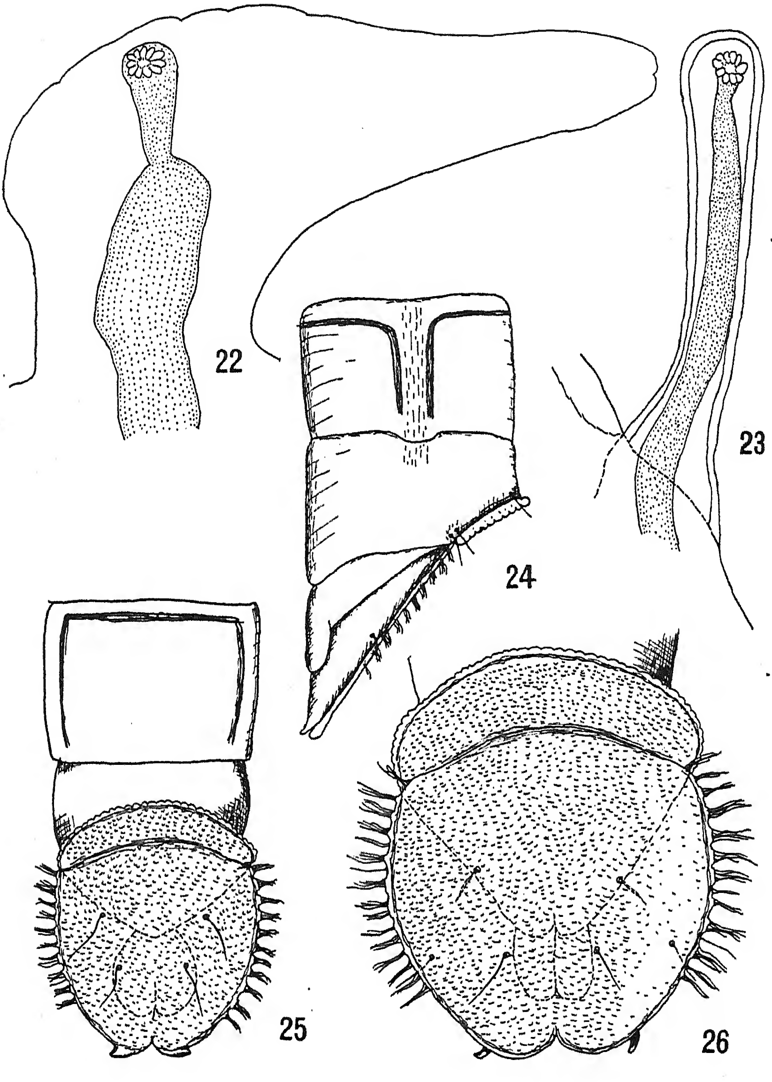

PLATE IV

Figures 22, 23. respiratory horn of pupa, dorsal view. 22. *frauenfeldi*. 23. *maritima*. Figures 24-26, terminal abdominal segments of pupa. 24. *maritima* (male), lateral view. 25. same, dorsal view. 26. *frauenfeldi*, (female) dorsal view.

(Note: All drawings made with aid of ocular grid to same scale; figures 1-23, high power, figures 24-26, low power of compound microscope.)

constriction about one-fifth way proximad of spiracle; a pair of long very fine hairs on each side of thorax mesad of respiratory organ, and three pairs of fine hairs near midline of dorsum just anterior to bases of wing-cases. Wing and leg cases project caudad; free from but closely appressed to lateral and ventral surface of body. Abdominal segments slightly wider than long, decreasing but very slightly in width progressively from I to VII, without evident hairs or bristles. Terminal segment obliquely truncate (figs. 24, 25), forming an oblique, dorso-posteriorly flattened emarginate elliptical shield. Face of this shield divided at upper fourth by a dorsally arched transverse suture; portion above this suture almost perpendicular to body axis, forming an angle with the posterior portion of shield; rim of anterior portion with heavily scletorized denticles without hairs; rim of posterior portion of shield with denticles fused in groups of from one to six and bearing long amber hairs except at posterior extremity which is divided into two bare rounded lobes each with a strong apical ventrally-directed curved spike or hook. Face of the shield with two pairs of long hairs placed sublaterally in a trapezoid on the posterior sclerite. The trunk of the eighth segment anterior to the shield is not sclerotized but bears long dark hairs as follows: a subdorsal pair at rim of shield, two pairs on each side near ends of the transverse suture of the shield and a pair about half-way back near the rim of the posterior sclerite of shield. The male gonostyles are prominent as two large flattened ventral lobes of eighth segment appressed to the venter of the shield.

Holotype, female; *Allotype,* male, Hong Kong, China, November 18, 1933, L. G. Saunders (balsam slide mounts).

Paratypes, 10 males, 1 female, Hong Kong, China, November 18, 1933, L. G. Saunders (alcoholic material); 3 males, 3 females, Noumea, New Caledonia, July 5, 1940, F. X. Williams, "running on sea rocks" (pinned).

The types will be deposited in the U. S. National Museum. The Hong Kong paratypes are in the collections of Dr. L. G. Saunders, the Bernice P. Bishop Museum, The California Academy of Sciences, and of the author; the New Caledonia material is in the Hawaiian Sugar Planters' Association Experiment Station collection. The Hong Kong material also included two pupal exuviae, one of which will be deposited in the U. S. National Museum and the other will be retained by the author; Dr. Williams' collection also included one pupal exuvium from Noumea, "floating on back-water." Larval specimens were not included.

T. maritima can be readily separated from other species of the genus by the following characters: second antennal segment tapering to base, not constricted in middle; last antennal segment gradually tapering to tip; clypeus and vertex with sparse setae; wing veins M, Cu, and 1st A not setose; hairs on hind legs of male about twice the diameter of leg, male dististyles swollen basally, with sharp tip; female cerci slender, gradually tapering from base. The pupae of *maritima* are quite similar to those of *frauenfeldi* in the structure of the terminal shield, though the shield of *maritima* is more elongately elliptical; but the thoracic respiratory organs are quite different.

5. **Thalassomyia africana** Edwards.

Thalassomyia africana Edwards, Proc. Zool. Soc. Lond., **51**: 787, 1926 (Tanganyika, E. Africa; male; on or near sea-shore); B. P. Bishop Mus. Bull. **114**: 88, 1935 (Marquesas Is.; female described).

Adult.—Length of wing, 2 mm. General color dark brown; legs chocolate brown, thorax and abdomen almost blackish, palpi, wing bases, and halteres yellow. Antennae 7-segmented; basal segment a little more than twice the diameter of the distal segments, about two-thirds as long as broad; second segment about twice as long as broad, but slightly constricted in middle; segments three to six subspherical, seventh segment nearly three times as long as broad, tapering at distal third to a long nipple-like tip; first segment with dense long setae, distal segments each with an encircling row of long setae, those of second segment on distal portion and of seventh segment on proximal portion. Palpi long, about twice the length of the antennae, proximal two segments short and broad, distal two segments greatly narrowed and elongate; color yellowish, with scattered long dark bristles on proximal segments and a few small light setae on distal segments. Clypeus quite convex, densely clad with long dark setae. Vertex flattened, with the anterior margin greatly curved in a semi-ellipse above the bases of the antennae and between the eyes; with many long dark setae laterally, almost bare in middle.

Pronotal lobes narrowly separated at midline by about the width of first antennal segment, each with a line of 10-12 long black setae. Mesonotum large, roundly arched; humeral depressions rather prominent, curved; a slightly raised longitudinal area just anterior to scutellum; with rows of long black setae as follows: a median longitudinal row from anterior margin of mesonotum to scutellum (about 25 setae); two sub-dorsal longitudinal rows failing to reach both anterior margin and scutellum by distance equivalent to that between sub-dorsal and median rows (20 setae each); and an irregular linear patch zig-zagging along each lateral margin from wing base to humeral depression (15 setae). Scutellum very convex, about half again as wide as long (partially denuded, ? setae); post-scutellum slightly longer, narrower, and flatter than scutellum, bare.

Wings covered with microtrichiae, appearing smoky grey-brown; costa and radius infuscated with light brown; costa and radial veins densely set with rather fine setae (in some specimens these are quite short, but in one specimen with long hairs on the legs, the setae at the base of the costa are especially long), other veins bare; squama and posterior wing margin fringed. R_1 enters costa at about half the length of R_{4+5}, R_{2+3} absent; Cu forks much beyond the base of r-m (at the level of tip of r-m), the fork very narrow at the base; Cu_1 subequal to base of Cu, slightly curved, Cu_2 well curved.

Legs with hair short, less than diameter of tibia in females and in one male, in the second male the hair on the legs is quite long, about three times the diameter of a tibia. Empodia and pulvilli especially long.

Abdomen with bristles moderately long and dense, these not reduced on posterior segments. Male genitalia turned through 180°, small. Basistyles broad at base, tapering distally, dorso-mesal surface hollowed out, dorso-lateral margin greatly produced at base in a thin integumental fold bearing a prominent flat thumb-shaped sclerotized lobe (fig. 10) bare except for half a dozen minute preapical setae. Entire ventro-mesal margin of basistyle thickly set with sharp setae, some quite fine and others spine-like, internal surface about midway near mesal margin with a group of half a dozen short, stout spines. Dististyles (fig. 6) quite narrow, curved, not greatly enlarged near base, but gradually tapering to apex which is rather bluntly pointed and bears two long setae at extreme tip; a third rather strong sub-terminal seta; proximal portion with many fine setae and long hairs. Aedeagus projects

dorso-caudad between the bases of the basistyles, consisting of a short dorsal hyaline penis lobe with rounded apical lips, flanked by a pair of long crooked laminiform heavily sclerotized guard plates with proximal third swollen and distal two-thirds narrowed and arcuate. Anal lobe prominent, just anterior to base of aedeagus. Female cerci narrow at base and tapering to a very slender down-curved apex; female genital segments pubescent, patch of long brown hairs on last sternite.

Material examined.—2 males, 2 females, Vaituha, Eiao, Marquesas Islands, at light, October 2, 1929, A. M. Adamson, coll. (Pacific Entomological Survey); from Bernice P. Bishop Museum collection.

The two females and one male with short hair on the legs were determined as *africana* by Edwards, who reported (1935) that they were carefully compared with the type male from Dar-es-Salaam and no specific differences could be found. The male with long hair on the legs was determined as *pilipes* by Edwards, but it is believed that this determination was erroneous. The specimens agree in all respects except the long hair on the legs with the specimens of *africana*, and the male genitalia, which were carefully dissected and mounted on a slip by the writer, also closely agree with *africana*. All the Marquesas material is therefore considered to be one species.

The most useful characters of *T. africana* are: dististyles slender, with blunt tip bearing two setae at extreme apex; basal lobe of basistyle large and thumb-shaped and bare at tip; long, extremely slender female cerci; wing veins M, Cu, and 1st A bare of setae; last antennal segment rather tapering toward terminal nipple.

6. **Thalassomyia longipes** (Johnson).

Galapagomyia longipes Johnson, Zoologica, **5**: 86, 1924 (Galapagos Is.; 1 male; 1 female); Edwards, Ins. of Samoa, pt. **6**, fasc. 2: 61, 1928 (? [=*pilipes* Edwards]).

Thalassomyia longipes Edwards, B. P. Bishop Mus. Bull. **114**: 87, 1935 (from *Galapagomyia*; ? [=*pilipes* Edwards]).

T. longipes and *pilipes* were considered as probably identical by Edwards, in which case *longipes* would have priority over the latter name; however in order to point out the doubtful status of this species, Johnson's original description of *Galapagomyia longipes* is quoted in full:

"*Galapagomyia longipes* gen. et sp. nov.

"*Male:* head yellowish, the prominent facial protuberence bearing long black hairs, the proboscis nearly as long as the face, palpi large, yellow with black hairs, antennae yellow, scape about three times the diameter of the first joint of the flagellum, the joints of the latter six in number, are rounded, and each bear three verticilli; the terminal joint, which is about double the length of the preceding joint, tapers to a point. Thorax brown, with three dorsal rows of hairs, pleura yellow, with a large brown central spot, scutellum

brown. Abdomen with both the dorsal and ventral segments brown, margined posteriorly with yellow, hypopygium comparatively small, in form similar to a *Diamesa*. Legs long, femora yellow, thickened at the basal half, tibiae brown, the front tibiae about one-fourth longer than the femora, the others but slightly longer; tarsi brown, the metatarsi about one-half the length of the tibiae, the other joints of the tarsi together not quite as long as the metatarsi, fourth joint less than one-half the length of the third; legs covered with fine black hairs, halteres yellow, wings brownish hyaline, the costa, first and second veins hairy. Length 4 mm.

"*Female*. Similar to the male but only 3 mm. in length. Ovipositor short. The eggs show distinctly through the thin distended sides of the abdomen.

"Two specimens in alcohol, Seymour Bay, Indefatigable, April 26th."

Edwards (1926) recognized *longipes* as a *Thalassomyia* soon after the description came to his attention. When describing *T. pilipes* from Samoa in 1928, he called attention to the possibility that his might be the same as Johnson's species. Then in 1935, when recording *pilipes* and *africana* from the Marquesas Islands, Edwards stated that he had succeeded in obtaining additional material from the Galapagos, collected by Miss Cheesman (though all specimens were damaged and lacked the abdomen) which agreed as far as he could tell with *pilipes*. In the present paper, it is shown (after examining genitalia of the male) that the specimen Edwards determined as *pilipes* from the Marquesas in reality represents an aberrant male of *africana* in which the hair on the legs is unusually long; this finding seriously hinders the use of the criterion of hairy legs with which Edwards likens *pilipes* and *longipes*. Moreover, Edwards states that *pilipes* is a dark species; from Johnson's description above, *longipes* seems to be lighter with a great deal of yellow coloration; this would suggest identity with *setosipennis* from Hawaii, but Johnson states that in *longipes* only the costa, first and second veins are hairy. Therefore it is deemed best to treat *longipes* as distinct from either *pilipes* or *setosipennis* until the types of *longipes* can be examined or fresh material obtained from the Galapagos. In an effort to locate Johnson's types of *Galapagomyia longipes,* inquiry was made of Dr. C. L. Michener of the American Museum of Natural History in New York, where it was thought that the material treated in "Zoologica" might be kept. As Dr. Michener could not locate the types there, he kindly referred the inquiry to Dr. J. Bequaert of the Harvard College Museum of Comparative Zoology in Cambridge, who replied that no specimen of *longipes* was in that Museum. Dr. Bequaert adds, "As Johnson's private collection of Diptera and all his types were acquired by this Museum, it would seem that Johnson did not retain the type of *T. longipes*." Appreciation is extended to Dr. Michener and Dr. Bequaert for their generous assistance in the search for the types.

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Ephydra gracilis Packard, a recent Immigrant Fly in Hawaii (Diptera: Ephydridae)[1]

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(Presented at the meeting of September 9, 1946)

The first recorded occurrence of *Ephydra gracilis* Packard in the Hawaiian Islands appears to be a specimen found in a light trap at Hickam Field in April 1946. A month later a second specimen was taken in a light trap operated on Sand Island opposite Honolulu. In April a lookout was begun for breeding places while on routine mosquito surveys on Oahu, but the habitat was not discovered until July 23.

The flies were found to be breeding by the millions in salt-water ponds opposite the Moanalua Gardens, the water in these ponds having become increasingly saline as dredging operations had closed the inlet from Keehi Lagoon. These flies skate around on the water surface, congregating in dense masses near the shore, and fly up a few inches when disturbed to alight quickly on the water again a foot or two away. They were seen to enclose themselves in a bubble of air which was captured under their wings, and to crawl by projecting sticks or stones to the bottom a few inches below where their long straight tarsal claws (a generic character) served well to anchor them as they crawled around, presumably ovipositing. This habit previously has been noted for *E. hians* Say in Great Salt Lake, Utah, but not for *gracilis*. The larvae and pupae were found in the dense algal masses in the water and in the upper layers of the algae-covered bottom ooze.

Essig (1926) briefly summarized the knowledge of *gracilis* existing at that time: "*Ephydra gracilis* Packard is 2.3 to 3.5 mm. long, opaque gray, paler beneath and with a slight green tinge above, and bright green legs marked with yellow. The larvae are somewhat transparent white 10.6 mm. long, the anal tube which has a basal and apical pair of forks, is from the base to the terminal fork 4.9 mm. long, each of the prongs of the terminal fork 1.6 mm., and each basal fork 2 mm. in length. They have 8 pairs of long prolegs. The larvae live suspended everywhere in the open water of Great Salt Lake and Salton sea, in salt water in San Francisco and adjacent to the Pacific Ocean at Laguna Beach, California. The fly was

[1] From the U. S. Quarantine Station, Honolulu, T. H.

introduced from Great Salt Lake into San Francisco Bay by railroad trains after the building of the cut-off at the lake; J. M. Aldrich, Psyche, **25**: 30, 1918."

Aldrich (1912) had previously given a description of *gracilis*, adult, larva, and puparium, with biological notes, in a review of the biologies of the western U. S. species of the genus *Ephydra*. The related species, *hians*, was often so abundant in western salt lakes that windrows of puparia several feet deep were driven on the beaches by storms; these when collected and prepared by the Indians were often used as food and given the name "Koo-chah-bie."

More recent collections (August 26, 1946) at Iroquois Point near Pearl Harbor on Oahu showed *gracilis* to be quite abundant there in salt marsh pools in which the water had evaporated almost to the saturation point of the contained salt. However, in pools in which salt crystallization had actually occurred *gracilis* larvae were killed, but an undetermined syrphid fly larva (probably *Lathyrophthalmus aeneus*) and larvae of a psychodid fly apparently were still thriving.

It is believed, in view of the habits of *Ephydra gracilis* and the circumstances surrounding its first discovered occurrence in the Hawaiian Islands, that the introduction of this species can be more definitely attributed to aircraft transport than can any other of the numerous recently discovered insect immigrants. The close proximity of favorable breeding habitats at California seaplane bases, the large numbers of adults produced at times, their habit of swarming into moving vehicles (where they are a pest, as in trains crossing Great Salt Lake), and finally the proximity of receptive habitats near the Oahu seaplane bases, together develop conditions favorable for insect "transplantation."

The writer is indebted to Dr. Curtis W. Sabrosky of the U. S. National Museum for confirming the determination of the Hawaiian specimens as *Ephydra gracilis*.

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A Review of the Genus Telmatogeton Schiner, with Descriptions of three new Hawaiian Species (Diptera: Tendipedidae)

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(Presented at the meeting of October 14, 1946)

INTRODUCTION

The genus *Telmatogeton* was proposed in 1866 by Schiner, who two years later described the first included species, *Telmatogeton sancti-pauli,* from adults and a remarkable pupa collected on St. Paul Island in the Indian Ocean during the voyage of the Novara. In 1900 Coquillett described *Telmatogeton alaskensis* from adults from Alaska. Johannsen (1905) gave a translation of Schiner's description of *Telmatogeton* and figures of *sancti-pauli,* and reprinted Coquillett's description of *alaskensis.* Kieffer in 1911 erected the allied genus *Paraclunio* for a new marine species, *trilobatus,* from California. In 1913 Terry founded the genus *Charadromyia* for two species from the Hawaiian Islands: *torrenticola,* of which the immature stages were described and life history notes were given, the species living in swift mountain streams; and *abnormis,* from adults only, the habitat of which was not given. Terry noted the close relationship between the Hawaiian species and *Telmatogeton,* especially in the peculiar truncated pupa, but in view of Schiner's incorrect description of the adult, Terry was led to place his species in a separate genus. Kieffer (1914) described two new marine tendipedids, *Paraclunio fuscipennis* and *P. minor,* from the Atlantic coast of South Africa. However Malloch (1915) placed Kieffer's *trilobatus* as a synonym of *alaskensis* Coquillett, which he transferred to the genus *Paraclunio.* In 1919 Kieffer, disagreeing with Malloch's action, held that *Paraclunio trilobatus* and *Telmatogeton alaskensis* belonged to different genera. In 1920 Kieffer proposed a new genus *Trissoclunio* for the two South African species described in 1914. Edwards in 1926 commented on *Paraclunio trilobatus* and *Trissoclunio fuscipennis* and in 1928 published in Konowia a critical review of the genus *Telmatogeton* and its close relatives. After examining type material Edwards showed that Schiner's description of the palpi of *Telmatogeton* as four-segmented was incorrect, these actually being incompletely two-segmented, in this respect resembling *Paraclunio* and *Charadromyia.* In comparing Cape Town material of *Trissoclunio fuscipennis* with co-types of *Telmatogeton sancti-pauli*

Edwards could find no differences. After examining a series of British Columbia specimens as well as a co-type from Alaska of *alaskensis,* and a co-type of *trilobatus* from California, Edwards believed that both species should be placed in *Paraclunio.* He also indicated that *Telmatogeton minus* (*minor* Kieffer) might be a small form of *sancti-pauli,* and mentioned an undescribed marine species from Chiloe Island, Chile. Saunders (1928) gave a detailed description of *Paraclunio alaskensis* with excellent figures, including the immature stages and detailed life history notes showing that this species is marine.

Beginning with Edwards' description of two marine species, *Telmatogeton trochanteratum* and *simplicipes* in 1931 from Chile, the geographical range of *Telmatogeton* was soon extended throughout the Pacific Ocean. Tokunaga described two new marine species from Japan, *japonicus* in 1933 and *pacificus* in 1935. Hesse at Cape Town, South Africa, in 1934 gave a detailed description of the adult, larva and pupa and ecological notes for a marine species distinct from *sancti-pauli* which he doubtfully referred to *Telmatogeton minor.* In 1935 Edwards described *Telmatogeton pusillum* from adults captured at light near the sea in the Marquesas Islands in the south central Pacific. Tokunaga gave a very complete account of the early stages of *Telmatogeton japonicus* in 1935. Womersley (1936) described *Telmatogeton australicus,* including immature stages, from a South Australian reef, and gave biological notes.

With the exception of Illingworth's (1931) record of *Charadromyia torrenticola* from the Waiahole ditch, Oahu, no notes on Hawaiian *Telmatogeton* appeared until Williams published his biological notes on Hawaiian Chironomidae in 1944. In this paper notes were given on *Telmatogeton pusillum* Edwards from the coasts of Oahu, *abnormis* (Terry), a freshwater species, was listed from Kauai, *torrenticola* (Terry) from the rapid streams, waterfalls, and flumes of Hawaii, Maui, and Molokai, and notes were given on two additional un-named freshwater species from Oahu (sp. #1) and Kauai (sp. #2). In an excellent plate, morphological details were given of various stages of some of these species.

In the present paper it is proposed to clarify the status of the species known to occur in the Hawaiian Islands, with the description of three new species and the presentation of biological notes. Keys have been constructed to the adults and the immature stages (when known) to include all known species from the world, although in the absence of some foreign material and because of brief descriptions of some of the species, the writer has been hindered in the use of most convenient characters and it may well prove that several of the described species are synonymous.

The types of the species described as new are deposited in the Bernice P. Bishop Museum at Honolulu. Paratypes have been furnished the U. S. National Museum, the British Museum, the Harvard Museum of Comparative Zoology, the California Academy of Sciences, the South African Museum, and the South Australian Museum.

Genus TELMATOGETON Schiner 1866

Telmatogeton Schiner, Verh. Zool. bot. Ges. Wien, **16**: 931, 1866; Novara Reise Zool., **2**: 25, 1868 (genus redescribed, *T. sancti-pauli,* sp. n.); Edwards, Konowia, **7**: 234, 1928 (syn.: *Charadromyia* Terry, *Trissoclunio* Kieffer, new synonymy; *Paraclunio* Kieffer distinct from *Telmatogeton*).

Charadromyia Terry, Proc. Haw. Ent. Soc., **2**: 292, 1913 (Hawaiian Is.; 2 freshwater species).

Trissoclunio Kieffer, Ann. S. Afr. Mus., **17**: 523, 1920 (genus erected for *fuscipennis, minor;* S. Africa).

GENOTYPE.—*Telmatogeton sancti-pauli* Schiner.

Adult.—Coloration generally brown to black, mesonotum usually pruinose, wings smoky pale brown to dark grayish black. Head small, deeply set under anterior margin of the arched mesonotum; eyes round, widely separated by the deeply excavated front, ocelli absent; a small black pigment spot, function unknown, situated on postgena behind each eye. Antennae seven-segmented and non-plumose in both sexes; basal segment (scape) large, second segment elongated, third to sixth subspherical, seventh elongated and generally tapering toward a nipple-like tip; palpi two-segmented, often incompletely so. Pronotum widely divided, the lobes small; mesonotum arched, robust; scutellum convex; postscutellum prominent, elongated. Wings well developed in both sexes, generally extending beyond tip of abdomen in male, not quite reaching tip of abdomen in female; broad, anal angle about 90°; subcosta parallel to costa, radial veins strong and setigerous R_1 short, R_{2+3} absent, R_{4+5} extending nearly to wing-tip, r-m long and oblique; M reaching wing margin posterior to wing-tip, Cu usually forks about level of r-m which is generally just proximad of middle of wing; Cu_1 nearly straight, Cu_2 strongly curved at tip, anal veins short, not reaching wing-margin. Halteres large with a broad knob. Legs long and slender, the front femora often clavate at base, not enlarged or modified at tip; a small blunt, thumb-shaped, heavily sclerotized spur at base of each tibia which is attached to a hyaline sheath arising at the end of the femur on flexor side; apical tibial spines small, single or double; basitarsus elongate, usually shorter on mid-leg, following two segments progressively much shorter, third and fourth subequal, fifth segment slightly longer than fourth, prominently trilobed; claws of female simple, long and sharp; of male typically bifid into a sharp inner arm and a knobbed pectinate outer arm, though extreme modifications of male claws may occur; empodium large and plumose; a lanceolate membranous lamella, probably analogous with the pulvilli, arising from the base of each claw, as well as one or more long setae in most species. Abdomen long and slender; segment eight of female markedly triangularly tapering and laterally compressed, cerci prominent; tip of male abdomen generally rotated between segments seven and eight to a maximum of 90° sinistrad or dextrad, genitalia

small, simple, basistyles broad, dististyles oval and flattened, without appendages, phallosome conical, dorsally directed, anal tube often prominent at base of eighth tergite.

Larva.—Elongate and cylindrical, generally pale greenish in first instars, darkening to olivaceous when mature. Head brown, heavily sclerotized, oval, eye-spots present, antennae (fig. 3d) small, large basal segment bearing apically three minute distal segments and a biramous membranous Lauterborn organ; mandibles (fig. 3b) large, dentated distally; maxillae (fig. 3e) simple, palp small and unsegmented; mentum (fig. 3g) broadly triangular, with a large median tooth and several smaller lateral teeth. Thorax with first segment larger than next two and bearing a bilobed pseudopod, each lobe crowned with many hooklets (fig. 3h) of varying sizes. Thoracic segments with imaginal leg-buds showing through integument laterally. Abdominal segments one to eight cylindrical and bare except for a few small setae; ninth segment rounded dorsally and bearing a pair of ventro-lateral pseudopods with several rows of stout curved hooks (fig. 3i) at apex; three short anal gills occasionally present.

Pupa.—Dark brownish to olivaceous in color; head ventral in position, adherent to thorax; antennal cases projecting latero-posteriorly over prothoracic lobes. Thorax rounding dorso-anteriorly, with a pair of prominent horn-shaped respiratory organs (fig. 6f) extending over head, position of spiracle variable, one-half to three-fourths way on lobe. Wing and leg cases free but appressed ventrally to body; scutellum transverse, postscutellum well defined as a posterior convex lobe about as broad as long. Halteres present as raised tubercles laterad of postscutellum. Abdomen eight-segmented, including a terminal obliquely truncated shield-shaped segment with a flattened dorso-posterior disc with emarginate dentated rim (fig. 6g). Preapical segments each with a narrow U-shaped sclerotized line along anterior and lateral margins of tergites and sternites; variable patches of shagreening present on some or all segments. Terminal abdominal disc divided at upper fourth to sixth by a slightly arched transverse suture, the sclerite above nearly perpendicular to body axis and without hairs on the marginal denticles; posterior sclerite sloping at about 45 to 60° with body axis, the emarginate rim with the denticles bearing tufts of fine amber hairs except at the posterior apex which forms two rather smooth lobes with a pair of curved posteriorly projecting spikes. The disc of the female pupa is usually more elongate, proportionately to the elongation of female genital segments of the female imago. In the male pupa (fig. 3c) the venter of the eighth segment bears two large appressed lobes containing the adult gonostyles, while in the female pupa there are in the same position a pair of small anterior lobes and a pair of large posterior lobes containing the developing ventral valves of ovipositor and the cerci respectively of the imago. The integument of the cephalothorax as well as the terminal abdominal disc, as readily shown in empty exuviae, is heavily sclerotized dark amber brown due to pebble-grained integumental thickenings or occasionally transverse wrinkles; the integument of the preapical abdominal segments except for the narrow U-shaped lines and occasional shagreened patches, is quite transparent.

Discussion.—The subfamily Clunioninae, of which *Telmatogeton* is representative, is distinguished from other Tendipedidae by the reduction of the pronotum to small lateral lobes, very short anepisternal suture, large front coxae, and absence of the cross-vein m-cu. The genus *Telmatogeton* belongs to a group of genera in which the fifth tarsal segment is deeply trilobed and the ovipositor of the female is conspicuously pointed. The other known genera with trilobed tarsi differ from *Telmatogeton* as follows: *Psammathiomyia* Deby (Europe) and *Halirytus* Eaton (Ant-

arctic Region), wings very short or absent in both sexes; and *Paraclunio* Kieffer (West Coast of North America) with the front legs of the male modified, femora swollen, tibiae with a tubercle at base, and hairs of tibiae strong, sometimes flattened.

The immature stages of *Halirytus* and *Psammathiomyia* are not definitely known, although Deby (1889) described a larva and pupa of *Psammathiomyia pectinata.* Thienemann (1915) suggested that Deby had described a different larva which Edwards (1926) believed might be that of a tipulid. The immature stages of *Paraclunio alaskensis* were admirably described by Saunders (1928) and from a study of Dr. Saunders' descriptions and figures as well as examination of material kindly furnished by him, no readily discernible larval or pupal characters could be found separating this species from *Telmatogeton.* Although the extreme modifications of the legs of *P. alaskensis* would possibly give it separate generic status from *Telmatogeton,* all other characters point to its close relationship, probably with the "*japonicus* group" proposed below. As specimens of the genotype, *Paraclunio trilobatus* Kieffer, were not studied and existing descriptions are inadequate, the two genera are maintained as distinct for the present.

BIOLOGY

Notes have been given on the immature stages of seven species of *Telmatogeton.* Perhaps the best and most complete account of larval and pupal morphology and biology is that of Tokunaga (1935) for *T. japonicus* from Japan. Hesse (1934) also gave very excellent descriptions and a biological account of the immature stages of *T. sancti-pauli* and *T. minor* from South Africa. Terry (1913) and Williams (1944) also gave notes on the Hawaiian species, *T. pacificus* (as *T. pusillum*), *T. williamsi* and *T. fluviatilis* (together as *T.* sp. #1) and *T. hirtus* (as *T.* sp. #2). Womersley (1936) described the larva of *T. australicus* from South Australia.

As pointed out by previous workers, the genus *Telmatogeton* appears to be transitional between the marine and fresh-water environments. It is quite remarkable that of all the Clunioninae, only *Telmatogeton* has been found to breed elsewhere than on rocky sea coasts and then only in the rapid mountain streams of the Hawaiian Islands. Hesse stated that the marine *T. sancti-pauli* could withstand immersion in fresh-water for several days and Tokunaga was able to rear *T. japonicus* from the second instar in fresh-water. It appears then, that the Clunioninae, an exceptional insect group in many respects, went to the edges of the sea to live but only *Telmatogeton* retained its ability to live in fresh-water, and in the Hawaiian Islands, with numerous torrential mountain streams reaching the sea, these midges began working their way up the

waterfalls to their present home in the rushing torrents. As usual with an adaptable stock in an island group, various species were evolved in Hawaii; the more obvious evolutionary changes which have taken place can be shown simply in the following diagram:

→ **T. hirtus**

(hairy vestiture develops)

→ **T. torrenticola**

(pectinate arm of both claws disappears; male claw of simple type)

→ **T. williamsi**

(pectinate arm further reduced on anterior claw)

→ **T. fluviatilis**

(male tarsal claws: sharp inner arm lengthens at expense of pectinate arm on anterior claw)

→ **T. abnormis**

(transition from sea- to fresh-water; few morphological changes)

— **T. japonicus**

The various fresh-water Hawaiian species appear to be closely related, forming a natural group for which Terry's name *Charadromyia* may be used.

The fresh-water Hawaiian species are apparently able to colonize only in water in rapid motion. No doubt this habit is due to an exceptionally acute demand by the immature stages for a combination of at least three factors: 1) high aeration, 2) constant moisture, and 3) freedom from waste materials. These factors are also met by the habitats on the spray-drenched coastal rocks selected by the marine species throughout the world. The fresh-water species are most often found at the falls and rapids of the larger mountain streams, where their whitish silken cases are usually built on the surface of boulders over which the water spills swiftly enough to prevent growth of thick deposits of algae. However in recent years most of the mountain streams have been tapped,

if not taken over entirely for the irrigation of the fields below. The adaptable *Telmatogeton* which were carried down in the irrigation water have been very successful in colonizing on the sides and bottoms of the rock-lined ditches and wooden flumes where the water runs swiftly and without interruption, even in the lowland sugar cane fields.

Habits of the adults.—The adult Telmatogeton are rather short-lived; Tokunaga gives 20 hours for *japonicus*. Consequently the light-colored newly-emerged adults immediately begin their reproductive functions. Hesse states that the eggs are already well-developed in the female pupae of *T. minor;* that in this species and in *sancti-pauli* the short adult life-span is engaged mainly in the copulatory function and oviposition, and that the adults are not known to feed. The writer has observed that the Hawaiian species become gravid while in the pupal stage. The adults are positively phototropic and the powers of flight, considered feeble by Hesse, are believed to be greater by Tokunaga who took numbers of *japonicus* at light, 600 meters from their breeding place. The writer has also taken *T. pacificus* and *japonicus* in light traps several hundred yards inland, though certainly they were assisted in these flights by strong on-shore winds. *T. williamsi* and *fluviatilis* must not be strong fliers, as these distinct species have not been taken outside the streams and flumes of their respective ranges in the Waianae and Koolau mountains of Oahu, though separated by a lowland of only a few miles width.

The adults of most marine species are generally nocturnal, the peak of the emergence coming just after dusk, and the young adults soon begin their characteristic rapid "scampering" over the rocks, the males actively seeking out the females for mating. These scampering adults are most often found at the highest prominence of the spray-drenched rocks, on the side facing the sea. The scampering motion is a combination of half-running, half-flying, with the wings fluttering; on the advent of approaching waves, some adults take flight momentarily, but others in more sheltered pits and crevices in the rocks hold on flattened to the rock with legs widely extended crab-like, and seem none the worse for their wetting. This extreme water repellence, necessitated by the constant deluge of spray and waves, is no doubt provided by the thick covering of non-wettable microscopic pile on all parts of the body and dense microtrichiae of the wings. Occasionally adults may be seen actively scampering, mating, and ovipositing during the day, even in bright sunlight but more often on cloudy days, but generally the day is spent resting on the shady side of moist rocks. The Australian species *T. australicus* is diurnal, according to Womersley, appearing by thousands on bright sunny days in summer. The fresh-water Hawaiian species are much more markedly diurnal and are quite active in bright sunlight, but may be found in greatest num-

bers resting, ovipositing, mating, and running about on the shady side of boulders just above the water line or where drenched by spray. These adults are often dislodged by large pelting spray drops or marginal ripples, to be carried downstream on the swift current, but may soon be seen working their way up again by their characteristic erratic racing flight just at the water surface, generally near the stream margin where the current is less swift. There are no records of natural enemies of the marine species, though as indicated by Williams (1939, p. 314) the predaceous dolichopodid fly, *Cymatotopus acrosticalis* Parent which is so abundant on Hawaiian shores, must take its toll of *T. pacificus* and *japonicus*, and the writer has observed *Lispa*, probably *metatarsalis* Thomson, a common anthomyiid predator, stationed on boulders at the beach waiting for passing insects. Williams (1944) notes an anthomyiid fly (*Lispocephala* sp.) and the fire ant (*Solenopsis geminata* [Fabr.]) predaceous on the freshwater species; to these the writer can add the jumping spider (*Hasarius* sp.) attacking *Telmatogeton* adults which venture too far up the sides of boulders from the spray-drenched water line.

The males of all *Telmatogeton* are remarkable in having the genital segments of the abdomen rotated through about 65-90°. In most other Diptera where rotation occurs, it is nearly always a full 180° or complete inversion. Although the torsion is most commonly to the left in *Telmatogeton*, individuals occur with the terminal segments normal or turned to the right. Saunders (1928) in discussing a similar phenomenon in the very closely related *Paraclunio alaskensis* concluded that these variations indicated that twisting did not occur immediately upon emergence as in other Diptera, but was the result of copulation; but Tokunaga observed that in *japonicus* the twisting took place in the "shining" phase of the pupal stage just before eclosion. Copulation takes place on the rocks with the male straddling the female and his abdomen usually to the right, although generally several males, which seem to be more numerous than the females and quite avid, become involved in a tangle during the competition. On the dorsum of the last abdominal segment of the males there is a membranous protrusible "anal tube" the function of which remains obscure, but which Saunders believed would most likely be used in copulation.

Egg.—The eggs of *T. japonicus*, the only marine species for which the egg is known, are stated by Tokunaga to resemble closely those of *Paraclunio alaskensis*. These number 150 to 190 in the newly emerged female and are almost all laid during her 20-hour lifetime, singly in small pits or crevices in the rocks of the habitat. Saunders describes and figures the eggs of *P. alaskensis*, which are ovoid, 0.4 by 0.2 mm. in size; with conspicuous micropyle, chorion smooth, shining; color yellow when deposited, darkening to dull olive green; these are inserted singly in the filamentous

algae of the habitat. Terry described the egg of *T. torrenticola,* a fresh-water species; these were said to be ovoid, 0.2 by 0.3 mm., micropyle conspicuous, chorion shining, color yellow darkening to olivaceous, and without gelatinous covering; deposited on end, micropyle up, in single layers on the rocks or submerged timbers just below the water surface, often in masses of several thousands. Williams figured the eggs of *T. williamsi,* apparently with a gelatinous covering enclosing the "shining dark-tipped eggs" which he stated were "found in clusters slightly under the water or at its edges," and which hatched in about a week in the laboratory.

Larval habitat.—The immature stages of all the marine species seem to prefer a fairly comparable habitat, on the seaward faces of algae-covered rocks between tide-marks and situated so as to be swept free of sand and debris by fairly heavy surf. Each species so far studied has been associated with a definite dominant alga-type. The South African species, *T. sancti-pauli* and *T. minor,* were found by Hesse rather closely associated with the algae *Porphyra capensis* on the Atlantic side of the Cape and *P. vulgaris* on the Indian Ocean side; the larvae of *sancti-pauli* forming their tunnels between the folded fronds of the algae where drenched by the waves only at high tide, and those of *minor* preferring to crawl about freely or in silken tunnels on the bare rock surface in the shade of the algae and at a somewhat lower inter-tidal elevation less subject to drying. Tokunaga found *T. japonicus* colonizing only on *Enteromorpha compressa, Ulva pertusa,* and *Monostroma* sp. in Japan; the young larvae often crawling about and building their tubes among the algae, but after the second instar confining their nests to the rock surface around the algal-bases, and rarely creeping out of the nest; he states that the food consists of fragments of the dead and living algae from their shelter. Although the larvae of *japonicus* were not discovered in Hawaii, the adults were confined to an area of bay-front boulders marked by a growth of the algae *Ulva* sp. and *Enteromorpha* sp. on the Hilo water-front near a large storm sewer outlet, indicating possibly that this species is adapted to water of low salinity as characterized by the algae. Williams (1944) found *T. pacificus* associated with the sparse growth of *Ectocarpus* at the upper tide belt; the writer has also observed this species on Oahu with the larval cases at the algal-bases and more commonly in the pits and fissures in the bare rock surface; the larvae in all stages were often seen with their heads and anterior fourth of the body protruding from the cases. In Japan Tokunaga found *pacificus* associated with the algae *Endocladia complanata, Nemalion pulvinatum,* and *Monostroma* sp. Saunders states that the larvae of *P. alaskensis* in British Columbia may be found in almost any matted growth of filamentous algae, preferably on the vertical sides of rocks, at the higher inter-tidal levels.

For the freshwater species, Terry's description of the habits of the larva of *torrenticola* are supported by those of the writer. The silken larval cases are most often built on the sides of boulders or on the smooth-rock bed of rapids and falls where the water runs swiftest. The larvae seem to fare best when the water is swift enough to sweep the rock bare of algae and diatoms though many cases are found where the algal layer is thin. Larvae have been found at depths of a foot or so in large streams and flumes, but are most numerous at a few inches below the water surface at the edges or in shallows. The larvae are commonly seen in all stages with their heads and anterior segments projecting free of the case, but they by no means rarely retreat within their tubes, probably to rest and molt. Larvae are very seldom seen entirely outside of a tubular retreat, probably forming quick prey if they do venture forth. Dissection of gut contents of *T. williamsi* showed an abundance of diatoms and filamentous green algae, as well as a mass of unrecognizable amorphous material, probably soil, organic matter or partially digested vegetation. The duration of the larval stages is not known for any species, but it is believed to be rather long, possibly several months.

Pupa.—Pupation takes place in a specially thickened portion of the case or tube occupied by the mature larva; in a fold within a frond of alga in the case of *sancti-pauli,* and on or in a pit or crevice in the rock surface in most other species. The pupal period was determined by Tokunaga as about two and a half days for *japonicus,* but Hesse states that in the laboratory the period for *sancti-pauli* was from four to seven days or more. In the marine species emergence of adults takes place at low tide when the pupae are exposed; Tokunaga found that in *japonicus* emergence is usually completed in about thirty minutes. In the fresh-water species pupation occurs in a thickened part of the larval tunnel near the water surface, and on eclosion the pupa wriggles out until the cephalothorax is free, the truncated abdominal disc probably serving well to hold the insect against the swift current. Various functions have been assigned to this remarkable abdominal disc. Terry described it as "sucker-like"; Saunders believed that it "is used as a piston in a tube to force the pupa to the surface when ready to emerge," and in addition to the latter function Tokunaga stated that the disc was used for protection in the open cylindrical nest case, serving to prevent the pupa from being washed away by the waves. It is most likely that the thick cylindrical truncated pupal abdomen with terminal disc of *Telmatogeton* is the shape naturally evolving as a result of exposure to the high pressures set up by the violent motion of the surrounding water, these forces being freely transmitted through the ends of the silken nest case. Then, through the development of strong marginal hooks and spines on the disc this structure was in turn developed into a device for holding the pupa more

tightly in the case and assisting in eclosion. It is interesting to note that in addition to the allied *Telmatogeton* and *Paraclunio,* one other genus—*Thalassomyia,* possesses this modified abdominal disc in the pupa. This character would serve to ally *Thalassomyia* more closely with the clunionines with trilobed tarsi thus leaving *Clunio* more or less isolated.

The seasonal occurrence of *Telmatogeton* is probably more marked in temperate regions. Hesse stated that with *sancti-pauli* "There is reason to believe there is more than one generation per year, but that the winter or colder and more moist part of the year is more favorable." In *japonicus* Tokunaga believed "there may be two generations a year, imagines emerging twice, in the spring and summer seasons." The seasonal fluctuation in numbers also has its parallel in the seasonal variation of size of adults, and is probably due to the drying out and recession of the algal beds during the hot summer weather, depriving larvae of food and shelter. The spring forms of *japonicus* are stated by Tokunaga to be much larger than the summer forms from the same locality; this is also discussed for *Paraclunio alaskensis* by Saunders. Such variation in size renders difficult any attempt to differentiate species by comparing sizes. In the Hawaiian Islands where there are no marked seasons and the ocean temperature is rather constant, no seasonal variation in size or numbers has been noted for either marine or fresh-water species, breeding being continuous. However, adults of *T. fluviatilis* collected in a Manoa Valley, Oahu, stream which had been seriously diminished by drouth were less than half the size of typical examples.

Systematic Treatment

Genus *Telmatogeton* Schiner.

Group A. *Charadromyia* Terry. (Hawaiian Islands; fresh-water species) Male tarsal claws elaborating from the bifid type found in *japonicus* to a simple condition as in female (figs. 1d; 2c, d, e; 4d, e); antenna with segments 3-6 bare, 7 elongated (figs. 1a, b; 2a; 3a, b); female genital segments bluntly conical; male phallosome conical, simple.

1. *torrenticola* (Terry)	Hawaii, Maui, Molokai
2. *hirtus* sp. nov.	Kauai
3. *williamsi* sp. nov.	Oahu
4. *fluviatilis* sp. nov.	Oahu
5. *abnormis* (Terry)	Kauai, Oahu

Group B. *japonicus* group. (Pacific coasts; marine) Male claws bifid, asymmetrical (fig. 5c); antenna with segments 3-6 bare, 7 short (fig. 5a); female genital segments moderately tapering; male phallosome conical, simple.

6. *japonicus* Tokunaga	Japan, Hawaiian Is.
7. *australicus* Womersley	South Australia

Group C. *simplicipes* group. (Pacific coasts; marine)
Size small, color light; male claws bifid, symmetrical, pectinate arm longer (fig. 5d); antenna with segments 3-6 without hairs (fig. 5b) (sense bristles present in *simplicipes*), last segment short, scarcely tapering; cubital fork of wing much beyond r-m in two species (fig. 5h); female genital segments very long and tapering in two species; male basistyles narrow, diststyles ovoid, prominent rounded lobe ventral to phallosome, which is slender (fig. 5g).

8. *simplicipes* Edwards — So. Chile
9. *pacificus* Tokunaga — Japan, Hawaiian Is.
10. *pusillum* Edwards — Marquesas Is.

Group D. *Trissoclunio* Kieffer. (Indian Ocean, So. Africa, So. Chile; marine)
Size moderate to large, color dark brown; male claws bifid, asymmetrical (fig. 7d); mid-trochanters of male with a long process or short knob ventrally; antenna with hairs on segments 3-6, last segment short and tapering (fig. 7a); female genital segments long and tapering, upturned (fig. 7b); male basistyles with dorsal margin setose, phallosome with prominent lateral apophyses (fig. 7c).

11. *sancti-pauli* Schiner — So. Africa, St. Paul Is.
12. *minor* (Kieffer) — So. Africa
13. *trochanteratum* Edwards — So. Chile

TABLE I

Tibial Spur Formulas,[1] Leg Ratios,[2] and Antennal Ratios[3] in Various Species of *Telmatogeton*

	Spurs	Leg Ratios			Antennal Ratio
		Front	Mid	Hind	
torrenticola	1:1:2	0.58	0.30	0.50	0.61
hirtus	1:1:1	0.50	0.28	0.50	0.51
williamsi	1:1(2):2	0.57	0.38	0.52	0.56
fluviatilis	1:1:2	0.60	0.43	0.50	0.59
abnormis	1:1:2	0.57	0.42	0.50	0.39
japonicus	1:1:2	0.54	0.40	0.50	0.42
pacificus	1:1:1	0.59	0.50	0.55	0.34
sancti-pauli	1:1:1	0.60	0.37	0.59	—
minor	1:1:2	0.60	0.37	0.50	—

[1] Fore, mid, and hind tibiae respectively.
[2] Length of basitarsus divided by length of tibia.
[3] Length of distal segment divided by combined length of remaining segments of flagellum.

Group A

1. **Telmatogeton torrenticola** (Terry).

Charadromyia torrenticola Terry, Proc. Haw. Ent. Soc., 2: 292, 1913 (male, female, immature stages; Maui and Hawaii; habits; figures).

Telmatogeton torrenticola Edwards, Konowia, 7: 236, 1928 (from *Charadromyia*); Williams, Proc. Haw. Ent. Soc., 12: 169, 1944 (Molokai, new locality; habits; figures).

Male.—Length of body, 6 mm.; wing 4.5 mm.; breadth of wing 1.3 mm. General color black, mesonotum, pleura, and postscutellum pruinose; legs, humeral angles of mesonotum, wing bases, halteres and pleura brown to brownish black; wings cloudy brownish black.

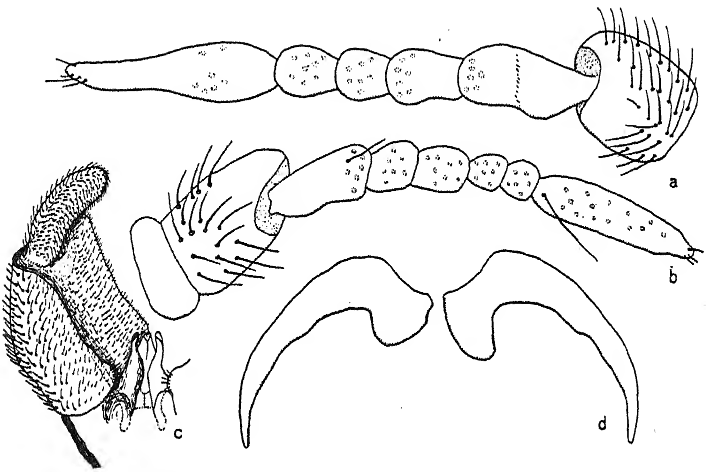


Figure 1. **a)** antenna, *T. hirtus;* **b)** same, *T. torrenticola;* **c)** male genitalia, *T. torrenticola* (right basistyle removed); **d)** tarsal claws of male, *T. hirtus* (*T. torrenticola* similar).

Antenna (fig. 1b) seven-segmented; basal segment large, subcylindrical, about half again as long as broad, its diameter about twice that of distal segments, with many long black setae on basal two-thirds; second segment about twice as long as broad at tip, appearing crooked due to a constriction at middle, with a long seta on distal portion; segments three to six subspherical, without setae; distal segment about four times as long as broad at base, proximal three-fourths subparallel, suddenly constricted apically to a small terminal knob, one or two long setae at base of segment; ratio of lengths of antennal segments beginning proximad, 55:40:20:18:14:14:65; entire antenna densely pubescent and flagellum with numerous sensory pits. Palpi incompletely two-segmented, the basal portion short, unsclerotized, bare; the distal portion sclerotized, about twice as long as wide, thumb-shaped, and with scattered long black setae. Paraglossae long and prominent,

larger than palpi, setigerous apically. Clypeus darkened and densely clad with numerous long black setae; vertex dark with patches of long black setae just above the eyes.

Lobes of pronotum each with three to five setae. Mesonotum large, strongly and narrowly arched anteriorly and overhanging the head, humeral angles indented; broadening midway and continuing full to wing bases; two short sublateral pre-scutellar furrows; four or five small setae in sub-dorsal rows (these may be absent), four or five long setae in each supra-alar group. Scutellum with about 30 long black setae, the longest of these not as long as length of scutellum; postscutellum long and bare.

Wings appearing opaque, dark brownish-black; radial veins and intervening area to costa darker, several small even darker spots scattered on subcosta; costa thickly beset with small spines, these becoming smaller toward wing tip, about 15-20 small setae on R, 6 on R_1, and 15 on R_{4+5}; other veins bare; squama fringed with about 30 long hairs, posterior margin with fringe of fine hairs becoming progressively shorter toward tip where they are almost imperceptible. Crossvein r-m about midway of wing, strong and oblique; R_1 entering costa at about two-fifths the length of R_{4+5} which is slightly curved, meeting costa well before the wing tip, which is rather roundly pointed and closer to tip of M than to R_{4+5}; M almost straight, very slightly sinuate, ending in wing margin just below wing-tip; fCu at level of base of r-m; Cu_1 gently curved to meet the wing margin at a 40° angle; Cu_2 strongly curved distad to meet the wing margin at right angles. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 16:6:15:14:19 respectively.

Legs long; relative lengths of segments from coxa distad, 5:2:14:18:10.4:3.7:1.8:1.8:3.8 on front legs, 5:2:22:19:5.7:2.5:1.5:1.5:3.8 on middle legs, and 6:2:25:22:11:5:1.7:1.6:2.5 on hind legs. Coxae large; trochanters simple; femora and tibiae slender; apical tibial spines single on front and middle legs, two on hind legs, pubescent at base; also a pair of small ventral spines at the tips of each of the proximal four tarsal segments of each leg. Last tarsal segment deeply trilobed, middle lobe extending to tip of claws, the lateral lobes about three-fourths as long; empodium long, pectinately plumose. All claws (fig. 1d) long and sharp; simple, not at all bifid; each claw with an adjacent lanceolate hyaline lamella mesad. Anterior side of coxae, trochanters and all of femora, tibiae and tarsi setigerous, setae of coxae especially dense, long and black.

Abdomen sparsely covered with very fine setae arising from light-colored ocellate spots, those on tergites practically disappearing posterior to fifth segment, while the hairs on the sternites remain quite prominent caudad to the eighth segment. First seven segments with a sublateral pair of narrow diagonal unpigmented lines with the bases cephalo-mesad, rather prominent in alcoholic specimens. Male genitalia (fig. 1c) small, rotated variably to right or left between seventh and eighth segments. Basistyles stout, slightly longer than wide, slightly tapering distad, concave dorso-mesally, with numerous short hairs laterally, fine setae mesad. Dististyles ovoid, flattened, infolded, slightly concave on flexor surface, slightly more than twice as long as broad, bearing dense fine setae, these directed proximad on flexor surface. Phallosome conical, directed dorsad from between bases of basistyles, the hyaline inner lobe with two lateral rounded apical lips, guarded on each side and fused on basal half with two sclerotized clavate plates which are narrowly united basally and joined by a sclerotized bridge to the dorsal articulation of the basistyles and to the proximal ends of the prominent rod-like sclerotized parameres which in turn project distally inside the basistyles. The membranous wrinkled pubescent anal lobe projects dorsally on the eighth tergite anterior to the phallosome.

Female.—Similar to the male in color, vestiture, and general characteristics, slightly larger in size, the wings not reaching the tip of the abdomen, the legs slightly shorter though the proportions of segments remain the same. Tarsal claws as in the male, long and simple. Eighth abdominal segment

narrowed laterally, triangularly tapering from side view, not as long as high; the cerci large and ovoid, located at pointed tip of abdomen at level of pleural margins of abdominal segments; the long slender dorsal valves of ovipositor enclosed by the cerci; the ovoid ventral valves located at tip of eighth sternite just anterior to and the apices enclosed by the cerci; entire genital appendages densely pubescent; eighth sternite with a patch of fine hairs just anterior to bases of ventral valves, rest of eighth segment practically bare.

The larva and pupa of *T. torrenticola* were described by Terry. The larvae are as described in detail below for *T. williamsi* with the following differences: 1) larger, length mature 12-16 mm.; 2) antenna longer, first segment about twice as long as wide; 3) mentum as in *hirtus,* rounding in outline, median tooth blunt, broadly rounding, six progressively smaller teeth on each side; 4) 19-23 hooks on each posterior pseudopod.

The pupa resembles those of the other Hawaiian species described below, with the following important specific details: 1) spiracle located at proximal third of respiratory lobe; 2) preapical abdominal segments with fine shagreening along basal median sclerotized lines on tergites and sternites, on third sternite there is a small triangular brownish patch of heavier shagreening in the center of basal shagreening; there are also small patches of fine slightly yellowish shagreening at the apex of each lateral sclerotized line on second to sixth tergites and third to sixth sternites; 3) terminal abdominal disc with the denticles heavily sclerotized brownish, the central area of the face of the disc with numerous raised fine tubercles, and about 10-13 hairs in submarginal area on ventral side on each side of genital lobes.

Material examined: From the Bishop Museum collection: *Maui:* 1 female, Nahiku, January, 1908, Terry coll.; 1 female, Haipuaena, C. N. Forbes, coll.; 1 female, Waihea, September 4, 1919, E. H. Bryan; 1 male, 1 female, Waikapu, June 11, 1920, Caum, coll.; 30 males, females, Iao Valley, January 3, 1915, J. F. Illingworth. From the H.S.P.A. collection: *Hawaii:* 10 males, 8 females, Kaumana, April 29, 1920, O. H. Swezey; 6 males, 4 females, Kohala, May 5, 1906, June 19, 1907, F. W. Terry ("In plantation flumes" —also 1 larva, 1 pupal skin); 1 female, Hilo Sugar Co., 1000 ft., July, 1932, F. X. Williams; 4 males, 1 female, Akaka Falls, October 24, 1931, F. X. Williams (wet rocks); *Maui:* 3 males, 11 females, Nahiku, January 9, 1908, F. W. Terry (also 2 clusters of eggs); *Molokai:* 1 female, Honouiliwai, December 1, 1933, F. X. Williams (1000 ft., rushing waters); 3 females, Moalua Stream, 2000 ft., November 29, 1933, F. X. Williams (at waterfall). Wirth collection: *Hawaii:* 100 males, females, Rainbow Falls, Hilo, February 27, March 3, 1946, W. W. Wirth (also numerous larvae and pupae); 30 males, females, Akaka Falls, March 3, 1946, W. W. Wirth; 1 male, Kohala ditch, March 1, 1946, W. W. Wirth.

Telmatogeten torrenticola is the only fresh-water species found on the islands of Hawaii, Maui and Molokai. It is distinctive in the large simple claws of the male, the large size, and reduced hairy vestiture. No unusual habits were noted while collecting adults, larvae, and pupae. This species was particularly abundant at Rainbow Falls, (400 ft. above sea level) about a mile and a half from the mouth of the Wailuku River, and one specimen was collected on the rocks along Hilo Bay about half a mile from the mouth of the river, where it had evidently been swept downstream by the swift current and had drifted along the bay-shore.

2. **Telmatogeton hirtus** sp. nov.

Telmatogeton sp. no. 2, Williams, Proc. Haw. Ent. Soc., **12**: 169, 1944 (notes; fig. 47, spiracular lobe of pupa; Kauai).

Male.—Length of body, 8-10 mm.; wing, 7-8 mm.; breadth of wing, 2 mm. General color black, pleura, mesonotum and postscutellum pruinose; legs, antennae, palpi, humeral angles of mesonotum, and scutellum dark brownish black; halteres brown; wing opaque brownish black. The most conspicuous feature of the entire insect is the marked elongation of the body hairs, most of these being as long as two to three times the diameter of the tarsi, and wavy towards the tip, giving the insect a remarkable "fuzzy" appearance.

Antenna (fig. 1a) seven-segmented; basal segment about one-fourth longer than broad, its diameter about twice that of distal segments, covered with many long setae; second segment about twice as long as broad, constricted in middle; segments three to six sub-spherical, without setae (sometimes only three of these segments present, the antenna appearing only six-segmented); distal segment four or five times as long as wide at base, markedly tapering from base to a long narrow tip bearing one or two fine subapical setae. Ratio of lengths of antennal segments, beginning proximad, 55:60:30:22:22:22:80; entire antenna densely pubescent and with numerous sensory pits. Palpi small and incompletely two-segmented, setigerous, basal segment sub-globular, enlarged, second segment short and oval; clypeus and vertex above eyes with numerous long black setae.

Lobes of pronotum each with fifteen to twenty long black hairs. Mesonotum large, strongly and narrowly arched anteriorly and over-hanging the head, humeral angles strongly indented; broadening widely and continuing full to wing-bases; two short, shallow but broad pre-scutellar furrows; about 6-15 long setae arising from light-colored ocellate spots in each subdorsal row; about 20 scattered hairs from ocellate spots in pre-scutellar patch; and about 20 hairs set close together in a common poorly sclerotized base in a compact supra-alar group. Scutellum with about 50 or more long black fine hairs, these somewhat longer than length of scutellum; postscutellum bare.

Wings appearing opaque dark brownish black; costa thickly set with long fine hairs, these gradually decreasing in length toward wing-tip where they are almost pile-like; base of radius thickly set with long hairs, these sparser and shorter on distal portion of radius, about 10-15 long setae on R_1, about 5-6 minute setae on R_{4+5}, other veins bare; squamae densely fringed with long wavy black hairs; posterior margin with a fringe of fine hairs becoming shorter toward wing-tip. Cross-vein r-m slightly beyond middle of wing, strong and oblique, R_1 entering costa slightly before half the length of R_{4+5}, which is slightly curved distad, meeting costa well before the wing-tip, which in turn is broadly rounded and situated about midway from the tips of R_{4+5} and M; M rather sinuate, fCu at level of base of r-m, Cu_1 gently curved, Cu_2 short and evenly but strongly curved to meet wing-margin at right

angles. Relative lengths of R, R_1, R_{4+5}, base of m, and distal section of M, 18:8:15:15:20 respectively.

Legs long; relative lengths of segments from coxa distad, 5:2:17:20:10:4:2:1.7:4 on front legs, 5:2:21:19:5.4:2:1.4:1.4:4 on middle legs, and 6:2:24:22:11:6:2:2:4 on hind legs. Coxae large, densely covered anteriorly with long black hairs; trochanters small, simple, only a few long hairs on antero-distal margin, remainder of legs slender and densely hairy, hairs very long and wavy, except shorter on ventral surfaces of segments; apical tibial spines single on all legs, also a pair of small ventral spines at the tips of each of the basal four tarsal segments of each leg. Last tarsal segment deeply tri-lobed, the lateral lobes about three-fourths as long as the median lobe; empodium long, pectinately plumose. Claws (fig. 1d) nearly as long as basal part of fifth tarsal segment, and twice as long as median lobe, sharp and simple, no trace of bifid condition except for a slight thickening at about proximal third of claw; each claw with a long lanceolate hyaline lamella (pulvillus) arising mesad at base.

Abdomen clothed with fine setae arising from light ocellate spots, these longest on first tergite, becoming shorter on posterior segments and on sternites; the anterior and lateral margins of each tergite and sternite more heavily sclerotized. Male genitalia turned to the right or left variably; basistyles stout, nearly as broad as long, slightly concave dorso-mesally, densely clad with coarse setae on lateral surface, fine setae mesally, disistyles sausage-shaped, slender, about three times as long as broad, scarcely tapering distad with rounded tips, folded mesad and clad with fine setae which are directed proximad on the flexor surface. Phallosome consists of a median dorsally directed hyaline tube with rounded lips guarded on each side and fused on proximal half with two hyaline plates tapering and recurving anteriorly to a sharp point; phallosome plates narrowly united basally and joined laterally to basal dorsal articulation of basistyles by a sclerotized bridge. Anal tube membranous, densely pubescent and wrinkled, opening on eighth dorsum anterior to phallosome.

Female.—Similar to male in size, coloration, and general characteristics. Vestiture of entire body, which in the male is so remarkably characterized by fine long wavy hairs, is in the female more or less as in other species of the genus; while the hairs and setae are quite dense and fine as in the male, the hairs themselves are quite short; those on the legs being about half as long as the breadth of the segment on which borne. The female claws are long, simple and curved as in the male. Eighth abdominal segment reduced, triangular in lateral outline, about half as long as high, and laterally compressed; the small bluntly rounded cerci borne apically on a line with the ventral margin of abdomen and enclosing the valves of the ovipositor; genital segment practically bare of setae, cerci pubescent.

Larva.—Length mature, about 12-15 mm.; head capsule 1.5 mm. long by 0.9 mm. wide. Color olivaceous green, head capsule sclerotized dark amber-brown, black along epicranial suture, cervical border, and distal half of mentum and mandibles; hooks of pseudopods dark brown.

Head barrel-shaped, slightly flattened dorso-ventrally, region of clypeo-labrum narrower and produced ventro-cephalad nose-like. Integument of head with pebble-grained sculpturing and irregularly wrinkled sclerotizations. Frons nearly twice as long as wide, widest at anterior third, anterior margin truncated by the transverse fronto-clypeal suture which is about three-fourths as long as greatest width of frons; frons bluntly pointed caudad at the junction of the arms of the epicranial suture. The post-clypeus is evident as a distinct small quadrate sclerite immediately cephalad of frons, slightly wider than long and a little more than half as wide as fronto-clypeal suture; the small transverse elliptical pre-clypeus is separate from and just anterior to the post-clypeus. The lateral and cephalic margins of the clypeo-labrum are roundly continued ventrally forming an overhanging "upper lip"

with the margins strongly sclerotized. The small antennae are borne laterally at level of fronto-clypeal suture, the large proximal segment is about twice as long as broad and about half again as long as the remaining distal segments, second segment peg-like, about a third as broad and a third as long as proximal segment, bearing two minute distal segments and several small spines; a biramous membranous Lauterborn's organ adjacent to and as long as distal three segments also borne at end of proximal segment. The dorsum of the head bears rather heavy amber hairs as follows: a pair just in front of antero-lateral corners of frons; a pair on the frons just within the antero-lateral corners; a pair on lateral margin of frons about a third-way back; a pair on the vertex just laterad of the arms of the epicranial suture at level of posterior third of frons; and several smaller hairs on each side scattered below and behind the antennae. A small irregular eyespot on each side of head just behind antennae.

Labrum folded downwards and emarginate; the cephalic margin bearing a variety of spines, pegs, and setae mesally, and several combs of long flattened hairs at sides; the paired premandibles borne laterad with the flattened 3-toothed apices directed mesad. The large heavily sclerotized mandibles bear five large blunt black teeth on distal third which is blackened, proximad of these on mesal margin is a small brown tooth and a stout hyaline distally directed spine reaching to the ante-penultimate tooth; there are two long setae on ventral surface of mandible near base and the dorsal surface bears a compact brustia of long hairs. The maxillae are flattened, rhomboid in outline, with a basal elongate sclerite bearing one or two long setae and a rounded distal sclerite bearing the short unsegmented truncated palpus. The anterior margin of maxilla is fringed with a beard of flattened setae progressively longer from base of maxilla; the distal margin around palpus bears a number of pegs and spines, and extreme posterior tip bears another beard of long flattened hairs. The mentum is nearly circular in outline except for base, the median tooth irregularly flattened in outline, quite broad, on each side are six sharp progressively smaller and shorter teeth counting the minute basal tooth; distal half of mentum blackened. Hypopharynx consists of a small median lobe heavily bearded with long flattened hairs supported by two slender sclerotized arms in a V-shaped bridge.

Prothoracic pseudopod bilobed at tip, each lobe crowned with many brown hooks ranging in size from small recurved hooklets or spines well up on posterior side to long slender slightly curved hooks at apex on anterior side. Thoracic and abdominal segments with setae more numerous and longer than in other species in genus; thoracic segments each with about six long black single or double setae on each side, abdominal segments I-VIII each with four scattered black setae on each side. Ninth segment rounded dorsally, indistinctly segmented into a ventro-posterior portion bearing the anus between a pair of stout pseudopods; these each with a mesally interrupted crown of 20-25 strongly curved stout black hooks at apex; adjacent to the anus are three sausage-shaped gills, the posterior or median unpaired gill longer, about three times as long as broad and nearly as long as a pseudopod, the pair of laterally projecting gills are about half as long and are directed to the hook-free portion of the pseudopods; the dorsal portion of ninth segment bears three sub-lateral pairs of fine black setae and a pair of quite long stout double or triple posterior hairs; each pseudopod with three or four black setae in a horizontal row about halfway on lateral side.

Pupa.—Length, about 9 mm.; color olivaceous green, darkening as the developing imago matures; exuvium sclerotized dark amber brown in region of cephalothorax and terminal abdominal disc, abdominal segments transparent except for narrow U-shaped sclerotizations along basal and lateral margins of tergites and sternites. A long hair arises just mesad of base of each antenna, a long hair on each humeral corner, two hairs just mesad of

base of each respiratory organ, a pair just anterior to wing bases and a pair of widely separated pre-scutellar hairs. Respiratory organ horn-shaped, as in genus, spiracle minute, opening dorsally on proximal third of lobe.

Abdominal integument shagreened, these markings much more pronounced and amber colored along anterior sclerotized lines of tergites; first tergite with a large central brown shagreened patch, tergites of II and III with brown shagreening covering most of segment; tergites and sternites of preapical segments each with about ten scattered black setae, these rather long in the male pupa, but reduced in the female. Margin of both dorsal and posterior sclerites of terminal abdominal disc with very coarse uneven brown heavily sclerotized denticles, on posterior sclerite these denticles bear a fringe of numerous fine amber colored hairs except at extreme posterior apex. Face of dorsal sclerite of disc with four long black hairs near margin, surface heavily and irregularly corrugated; face of posterior sclerite bears two pairs of long black hairs in a submedian trapezoid, surface with pebble-grained thickenings, especially along margins, two submedian brown longitudinal lines are distinctive. Trunk of eighth segment anterior to disc not sclerotized but bears long black hairs as follows: a sublateral pair and a pair at extreme lateral extremity of dorsal sclerite of disc, two lateral pairs just ventral to ends of transverse suture of disc, three sublateral pairs on each side of and anterior to genital lobes, three to five pairs of sublateral hairs where trunk of eighth segment joins the disc, and eight to ten hairs scattered on each side along ventral margin of disc.

Holotype, male, *allotype,* female, Wainiha stream, Kauai, September 8, 1946, W. W. Wirth; *paratypes:* 3 males, same data as types; 1 male, 3 females, Kokee stream at falls into Waimea canyon, Kauai, September 6, 1946, W. W. Wirth; 5 males, 4 females, Kokee, Kauai, Kauaikinana stream, June 9, 1919, H. T. Osborn. *Other material examined:* From Bishop Museum collection: 1 battered torso, Kauai, 4000 ft., April 23, 1919, J. A. Kusche. From H.S.P.A. collection: 1 pupal exuvium, Halemanu, Kauai, June 10, 1919, H. T. Osborn. Wirth collection: many larvae and pupae, Wainiha stream, Kauai, September 8, 1946, W. W. Wirth (on boulders in rapids); many larval, pupal skins, Kokee stream, Kauai, September 6, 1946, W. W. Wirth (at falls into Waimea canyon).

Telmatogeton hirtus has been taken only on the island of Kauai, where it is evidently widespread in the numerous rapid mountain streams draining the Alakai Swamp, a very wet region at about 4000 ft. elevation with as much as 600 inches of rainfall annually. This species was found together with *T. abnormis* (Terry) at Kokee stream, this being the only instance in which the range of two fresh-water species has been found to overlap; the two species are evidently not immediately related and are readily separated in all stages. The habits of *hirtus* were not observed to be different from those of other fresh-water species in any respect.

T. hirtus is readily distinguished from other species by its large size (largest in the genus), the remarkably developed hairy vestiture, especially in the male, the simple tarsal claws of the male, the development of setae on the larvae and pupae, the anal gills in the larva (also present in larvae of *abnormis* from Kauai), and the pair of prominent longitudinal lines on the abdominal disc of the pupa.

3. **Telmatogeton williamsi** sp. nov.

Telmatogeton sp. no. 1 (in part), Williams, Proc. Haw. Ent. Soc., 12 : 168, 1944 (biological notes, Waianae, Oahu; figs. 44-46, egg and pupa).

Male.—Length of body, 3-5 mm.; wing, 3 mm.; breadth of wing, 1.0 mm. General color blackish, pleura, mesonotum, and postscutellum pruinose; legs, antennae, palpi, humeral angles of mesonotum, and genitalia dark brownish black; wing dark cloudy gray; halteres light gray.

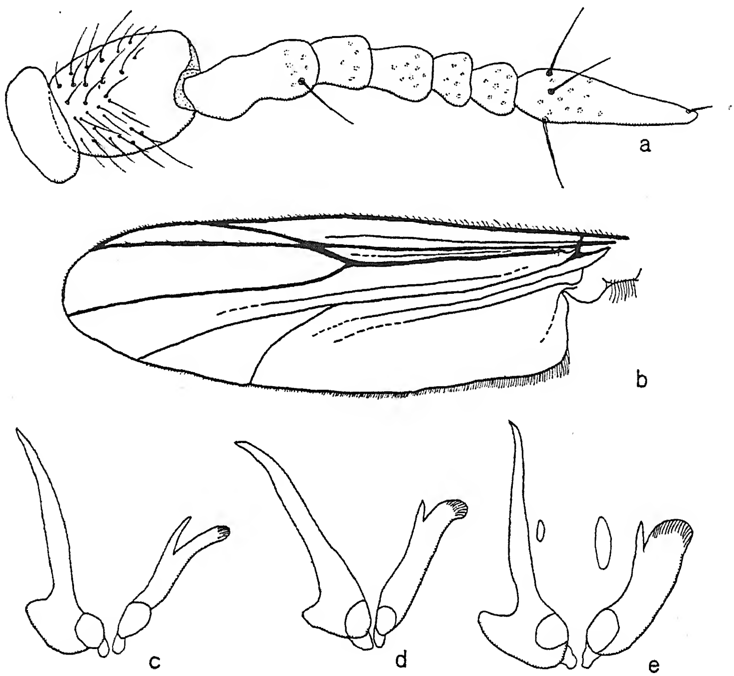


Figure 2. *T. williamsi.* **a)** antenna; **b)** left wing; **c)** claws of front tarsus of male; **d)** same, mid tarsus; **e)** same, hind tarsus.

Antenna (fig. 2a) 7-segmented; basal segment large, sub-cylindrical, slightly longer than broad, its diameter about twice that of distal segments, with many long setae; second segment about twice as long as broad at tip, slightly crooked and constricted at middle, bearing a few long setae on distal portion; segments three to six sub-spherical, without setae; distal segment about four times as long as broad at base, strongly but regularly tapering to a finely pointed tip, and bearing two to three long setae at base; ratio of lengths of antennal segments, beginning proximad, 45:40:16:19:12:12:55; entire antenna densely pubescent, segments of flagellum with numerous sensory pits. Palpi one-, sometimes two-segmented, the short bulbous basal segment only occasionally present; the second segment variable in form, but generally ovate, not quite twice as long as broad, with numerous setae.

Paraglossae small, round, setigerous. Clypeus and vertex darkened and bearing numerous strong black setae.

Lobes of pronotum with a few black setae. Mesonotum large, strongly arched anteriorly, extending part way over head; almost bare, the setae small, arising from light-colored ocellate spots, and restricted to a few (6) in each subdorsal row and a small supra-alar patch (6). Pleura bare, grayish brown pruinose. Scutellum with 40-50 black setae, these about as long as half the length of scutellum, postscutellum bare.

Wings with four or five small more darkly infuscated spots on subcosta; costa with numerous short spines throughout its length, these becoming shorter toward apex of wing; base of R with two long hairs, one or two small setae on R_1, R_{4+5} with about six small setae, other veins bare; squama fringed with about 15-20 long hairs; fringe of fine hairs on posterior wing margin growing progressively shorter distally until almost imperceptible at tip of Cu_1. End of stem of radius somewhat indefinite, cross-vein r-m strong and oblique, R_1 entering costa at about one-half the length of R_{4+5}, which is slightly curved toward tip and enters costa slightly before the wing-tip; M almost straight, very slightly sinuous; Cu_1 straight except gently recurved apically to meet the wing margin at a 40° angle; Cu_2 straight on basal half, apical half curved to meet the wing margin at right angles; fCu slightly beyond base of r-m. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 11:5:12:9:15 respectively.

Legs long; relative lengths of segments from coxa distad, 4:2:14:13:7.4: 3:1.5:1.3:2.6 on front legs, 4:2:19:13:5:2:1.3:1.2:2.3 on middle legs, and 4:2:18:13.5:7:4.2:1.5:1.4:2.3 on hind legs. Coxae large; trochanters simple; apical tibial spines one on front legs, one or two on middle legs, and two on hind legs. Last tarsal segment deeply trilobed, the median lobe extending to apex of claws, lateral lobes three-fourths as long; empodium large, pectinately plumose. Tarsal claws (figs. 2c, d, e) unevenly bifid, the lateral tooth being pectinate at tip; on the inner (anterior) claws the lateral tooth is reduced to a small basal projection, while on the outer (posterior) claws the inner tooth is a fine spur arising well toward the tip of the pectinate tooth. Each claw with an adjacent membranous lanceolate lamella and a prominent seta arising near base. Anterior side of coxae and trochanters and all of femora, tibiae and tarsi setigerous.

Abdomen sparsely covered with very fine hairs arising from light-colored ocellate spots. Male genitalia variably rotated; basistyles stout, strongly setigerous ventro-laterally and with fine setae on dorso-mesal surface, with a small dark finely-setigerous lobe on dorso-mesal side near base; disistyles oval, flattened, concave ventrally, folded mesad, with fine setae, these directed proximad on flexor surface. Phallosome conical, inner hyaline lobe dorsally directed with two rounded lateral lips at apex, closely guarded by two lateral apophyses which are fused with inner lobe on proximal two-thirds. Anal tube prominent, membranous and wrinkled, pubescent, on eighth dorsum anterior to phallosome.

Female.—Similar to the male with the following differences: Generally slightly larger; length 4-6 mm.; wing 3-4 mm., broader than in male, not reaching tip of abdomen, especially in gravid specimens. All tarsal claws long, pointed, simple, not bifid. Eighth abdominal segment markedly tapering, triangular in outline, laterally compressed, bare except for a few very fine sparse setae at apex of sternite; ventral valves of ovipositor short, oval, separately placed mesally; dorsal valves nearly as long as cerci within which they closely fit; ovipositor and cerci finely pubescent; a small patch of long setae arise from sclerotized base of ventral valves.

Larva.—Length mature, about 10 mm., head capsule 1.1 mm. long by 0.6 mm. wide. Color olivaceous green, light in younger instars becoming quite dark in mature specimens, head capsule amber to dark brown, especially darkened along epicranial suture; mandibular teeth, mentum, cervical border of head capsule, and hooks of pseudopods black.

Head oval, slightly tapering to anterior, sub-cylindrical in cross-section. Frons about twice as long as wide, widest in middle, curved to a point caudad at junction of arms of epicranial suture; curving anteriorly to base of clypeus which it touches in a transverse suture about half as long as greatest width of frons, two pairs of small hairs borne on lateral borders of frons, one near anterior corner, and the second about one-third of the way back; four small hairs on each side of head, one adjacent to anterior frontal hair near epicranial suture, second near suture, but posterior to first by about half the distance to the sutural fork, a third about the same distance ventrad of the second, and the fourth just ventral to the eyespot. A long hair borne on a large tubercle just laterad of each end of fronto-clypeal suture. Antennae

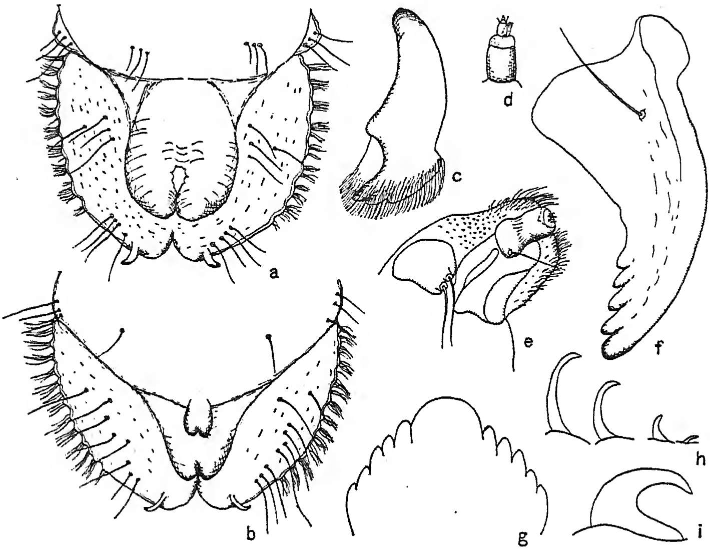


Figure 3. *T. williamsi,* larval and pupal details. **a)** posterior portion of terminal abdominal disc of male pupa, ventral view; **b)** same, female pupa; **c)** premandible of larva; **d)** antenna of larva; **e)** maxilla of larva; **f)** mandible of larva; **g)** mentum of larva; **h)** hooks of anterior pseudopod of larva; **i)** hook of posterior pseudopod of larva.

(fig. 3d) borne laterally at level of fronto-clypeal suture, small and four-segmented; stout basal segment slightly longer than broad bearing a peg-like second and two minute distal segments and a Lauterborn's organ adjacent to and as long as these. A small eyespot located laterally just behind base of mandibles. Post-clypeus small, transverse, about half again as wide as long; pre-clypeus minute and semicircular. Labrum rounding anteriorly, curved dorsally with minute papillae, four hairs widely spaced in a square, anterior margin with a row of ventrally directed spines between two lateral brush-like tufts of hairs; arising posteriorly to these, a pair of appendages (fig. 3c) (premandibles) elongate basally, bearing apically a flattened hairy spatulate outer leaf and a bare flattened inner arm with three flat rounded teeth.

Mandibles (fig. 3f) large, heavily sclerotized, with five large blunt teeth on apical third, two long lateral setae ventrally, and a brustia of long hairs dorsally near base. Maxillae (fig. 3e) rounded, short, bearing several dense

patches of hairs and setae laterally and apically; with a small basal sclerite bearing two long setae, and a principle sclerite bearing a small unsegmented spindle-shaped palp with a hair at base and a number of blunt thick setae at the center of the truncated apex. Mentum (fig. 3g) triangular in outline, with a large rounded median tooth and five small blunt lateral teeth on each side. Hypopharynx consists of a small transverse lobe thickly covered with long hairs, setae and patches of blunt spines borne anteriorly on a sclerotized V-shaped bridge.

Prothoracic pseudopod shallowly bilobed at tip, each lobe bearing a crown of many black hooks (fig. 3h) increasing in size from short curved spines at base to long slender curved hooks at apex. A few fine single or double hairs laterally on each thoracic and abdominal segment. Ninth segment rounded dorsally, indistinctly segmented into a ventro-posterior portion bearing the anus between a pair of short pseudopods, these each with a posteriorly interrupted crown of about 18 strongly curved stout hooks (fig. 3i) of varying sizes at apex; dorsal portion of ninth segment bears a laterally spaced caudal pair of prominent double hairs; no trace of anal gills.

Pupa.—Length, about 6 mm., stout. Anterior margin of cephalic lobe broadly rounded, not bilobed; a long hair arises just mesad of the base of each antenna. Mesothorax arched antero-dorsally, a prominent forward projecting horn-shaped respiratory organ arises from each humeral corner, spiracle at basal third of lobe; three long and one short hairs on mesonotum mesad of each respiratory organ; one long mesonotal hair just anterior to each wing-base, and a pair of widely-separated pre-scutellar hairs; entire mesonotum transversely corrugated. Preapical abdominal segments with narrow delicately shagreened areas bordering the U-shaped sclerotized lines on tergites and sternites; about four minute bristles on each side of each tergite. Dorsal sclerite of terminal abdominal disc with four long black hairs near margin, ventro-posterior sclerite with four long dark hairs placed in a submedian trapezoid. The trunk of eighth segment anterior to the disc is not sclerotized, but bears long black hairs as follows: (figs. 3a, b) a dorso-lateral pair, a line of three hairs grouped near ends of transverse suture of disc, an irregular submarginal row of 8-10 hairs near edge of ventro-posterior section of disc, and a ventro-lateral pair (in female; 3 pairs in male) near base of eighth segment.

Holotype, male, *allotype,* female, Waianae, Oahu, May 2, 1946, W. W. Wirth; *paratypes:* 49 males, 24 females, same data as the types; 27 males, 5 females, Waianae, Oahu, January 23, 1946. *Other material examined:* hundreds of males, females, larvae, pupae, eggs, same data as the types.

All the above specimens were taken from a rock-lined ditch located at about 250 feet elevation about three miles inland from Waianae village. This ditch received swift-flowing water from high up on Mt. Kaala (el. 4000 ft.) which was led downward through a tunnel and discharged through a hydro-electric power-house. The ditch supplied much of Waianae Plantation with water for sugar cane irrigation, hence was kept constantly running. A large number of insects, originally inhabiting the swift mountain streams, have taken up residence in this ditch and similar ditches and flumes supplying the cane fields; such insects include in addition to *Telmatogeton, Scatella hawaiiensis* Grimshaw, *S. warreni* Cresson, *S. bryani* Cresson, *S. oahuensis* Williams, *Procanace nigroviridis* Cresson (*Ephydridae*); *Dasyhelea hawaiiensis* Macfie

(Heleidae); *Tanytarsus lacteiclavus* Grimshaw (Tendipedidae); and *Lispocephala fusca* Malloch (Anthomyiidae).

T. williamsi is quite similar to the other fresh-water species; the male tarsal claws and the shape of the last antennal segment are most distinctive. Great pleasure is taken in dedicating this species to Dr. F. X. Williams, who has contributed so much to the study of aquatic insects in Hawaii.

4. **Telmatogeton fluviatilis** sp. nov.

Charadromyia torrenticola Illingworth, Proc. Haw. Ent. Soc. **7**: 408, 1931 (in Waiahole ditch).

Telmatogeton sp. no. 1 (in part), Williams, Proc. Haw. Ent. Soc. **12**: 168, 1944 (biological notes; Koolau Mts., Oahu).

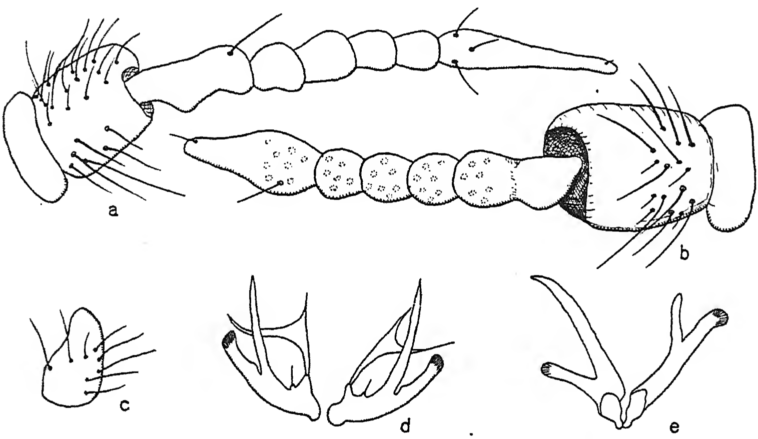


Figure 4. **a)** antenna, *T. fluviatilis;* **b)** same, *T. abnormis;* **c)** palpus, *T. fluviatilis;* **d)** male tarsal claws of *T. fluviatilis;* **e)** male tarsal claws, *T. abnormis.*

Male and female.—Very closely allied to *T. williamsi,* which it closely resembles in size, coloration, and general characteristics, but differs distinctly as follows: Terminal segment of antenna (fig. 4a) proportionately longer and much more narrowly tapering at tip; ratio of antennal segments beginning proximad, 40:40:17:20:15:15:62. Claws of all male tarsi (fig. 4d) alike, deeply bifid into a long sharp inner arm and a slender pectinate outer arm about two-thirds as long as the inner; female claws long and simple as usual in genus. Ratio of lengths of segments of leg, from coxa distad, 3.3:1.6:12:11:6.6:2.5:1.3:1.2:2.4 on front legs, 3.1:1.5:17:12:5.2:2:1:1:2 on middle legs, and 3.2:1.5:17:14:7:3.5:1.4:1.2:2.1 on hind legs. Tibial spines 1:1:2. Fewer bristles on scutellum (20-40), these longer, the longest about as long as length of scutellum. Hairs on abdominal tergites longer, especially on the anterior segments. Wings slenderer than in *williamsi,* the fork of Cu occurs slightly proximad of r-m rather than slightly beyond; the setae are longer and more numerous on the radial veins, there being about 20 on R and and R_1, and 5 or 6 on R_{4+5}. Wing length 2.5-3.5 mm.; breadth 0.8-1.0 mm.; body length 3.5-5 mm.

Larva.—Length about 10 mm. As in *williamsi;* proximal antennal segment longer, being fully twice as long as wide; mandibles 5-toothed; mentum 11- or 13-toothed counting a minute lateral tooth, rather rounded distally with a broad rounded median tooth; 20-30 hooks on posterior pseudopods, no trace of anal gills.

Pupa.—Length, about 6 mm. Very similar to *williamsi;* margin of cephalic lobe broadly rounded; respiratory organs as in *williamsi,* preapical abdominal segments minutely shagreened, these markings more prominent along basal transverse sclerotized lines and at tips of lateral lines on each tergite and sternite; at base of third sternite there is a prominent brown patch consisting of round tubercles with pitted apices, probably the most diagnostic marking of the species in the pupa; terminal disc as in *williamsi,* except with the face quite smooth, the marginal denticles less prominent and the tufts of marginal hairs slightly sparser.

Holotype, male, *allotype,* female, Kipapa, Oahu, April 9, 1946, W. W. Wirth (Waiahole ditch); *paratypes:* 50 males, 35 females, same data as the types; 17 males, 9 females, Kipapa, Oahu, February 8, 1946, W. W. Wirth (Waiahole ditch); 17 males, females, Manoa Valley, Oahu, April 10, 1946, W. W. Wirth (at falls). *Other material examined:* From the Bishop Museum collection: 4 males, 4 females, Waiahole ditch, Waipio, Oahu, April 26, 1936, Kiyoshi Ito (PPCA coll.); 6 males, 1 female, Waiahole ditch, Oahu, March, 1915, J. F. Illingworth. From the H.S.P.A. Exp. Sta. collection: 2 males, 1 female, Lulumahu stream, Oahu, April 11, 1937, F. X. Williams; 2 males, Waiahole, Oahu, August 11, 1926, F. X. Williams, 1 female, Manoa, Oahu, November 14, 1929, O. H. Swezey (Aihualama Falls). Wirth collection: 2 males, Punaluu Valley, Oahu, May 14, 1946, W. W. Wirth (concrete ditch from water tunnel).

T. fluviatilis has so far been found only in the streams and ditches from the Koolau mountains, Oahu, as far northwest as Punaluu Valley on the windward side; in the adjacent moist Kaluanui Valley its place is taken by *abnormis,* previously known only from Kauai. The paratypes taken from Manoa Valley were quite small compared to Kipapa specimens; this was probably due to unfavorable breeding conditions resulting from the reduction of the stream by extended dry weather; they agreed in all other details with the Kipapa types. The most distinctive characters are the shape of the male tarsal claws, the long narrow last antennal segment, and the prominent brown patch on the third sternite and the smooth face of the terminal disc of the pupa.

5. **Telmatogeton abnormis** (Terry).

Charadromyia abnormis Terry, Proc. Haw. Ent. Soc., **2**: 295, 1913 (Kilauea, Kauai; male and female).

Telmatogeton abnorme Edwards, Konowia, **7**: 236, 1928 (from *Charadromyia*).

Telmatogeton abnormis Williams, Proc. Haw. Ent. Soc., **12**: 168, 1944 (fresh-water, Kauai).

Male.—Length of body, 4.5-5.0 mm.; wing, 3.0 mm.; breadth of wing, 1.0 mm. General color blackish; pleura, mesonotum, and postscutellum pruinose; humeral angles of mesonotum, pleura, wing roots, and scutellum brownish, wing dark cloudy grayish-brown.

Antenna 6- or 7-segmented exclusive of the ring-like antennaria (fig. 4b); basal segment large, subcylindrical, slightly longer than broad, its diameter about twice that of distal segments, with many long setae from proximal portion; second segment twice as long as broad; rather crooked, and constricted in middle (as in most other species) appearing almost as two separate subspherical segments, without setae; segments III to V (and VI when present) subspherical, without setae; distal segment about two and a half times as long as broad at base, gradually tapering on distal two-thirds to a long nipple-like tip, with a fine seta near base, apex of segment I, all of II to V (VI), and base of VII with numerous sensory pits; ratio of lengths of antennal segments, beginning proximad, 48:34:15:15:15:(15):35. Palpi indistinctly two-segmented, thumb-shaped, about three times as long as broad, 6-8 setae scattered on distal portion. Paraglossae small, oval, about twice as long as broad, with scattered setae. Clypeus with numerous fine setae, vertex bare except for a small patch of about 10 moderate setae above and behind each eye.

Lobes of pronotum with 5-6 small setae. Mesonotum large and full, strongly arched anteriorly, flattened between wing-bases; almost bare, the setae reduced to 2-5 in each subdorsal row and 5-6 in a small supra-alar patch, setae all arise from light-colored ocellate spots. Scutellum convex, with about 30 black setae, the longest of these about as long as length of scutellum, postscutellum prominent, bare.

Wings with anterior veins heavy and brownish-infuscated; costa with very fine sharp scattered spines its entire length, these particularly sparse at base of costa; radius with a few setae, 2-3 on R, 4-5 on R_1, and 1 or 2 on R_{4+5}; other veins bare; squama fringed with about 30 very fine hairs; posterior wing margin fringed with fine hairs, these decreasing in length distad until barely perceptible at wing tip. R_1 enters costa at about three-fourths way of wing; R_{4+5} nearly straight, ending in costa just before wing tip; M slightly sinuous, ending in wing margin just below wing tip, Cu_1 gently curved, Cu_2 curved to meet wing margin at about 85-90°; base of r-m slightly proximad of middle of wing, fCu at level of base of r-m. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 10:5:11:9:13 respectively.

Legs long; relative lengths of segments from coxa distad, 3:1.5:11:11:6.3:2.5:1.1:1:2 on front legs, 3:1.5:15:12:5:2:1.2:1.1:2 on middle legs, and 3:1.5:16:14:7:4:1.2:1.1:2 on hind legs. Coxae large, trochanters simple, front femora clavate basally, other segments of legs slender; apical tibial spines one on front and middle legs, two on hind legs. Last tarsal segment deeply trilobed, lateral lobes nearly half as long as median lobe which is about half as long as portion of segment proximad of base of claws. Tarsal claws (fig. 4e) unevenly bifid, with a sharp inner arm and a pectinate outer arm; on the anterior claws of all legs the sharp inner arm arises about halfway on the side of the pectinate arm, the distal portions of the two being subequal in length; on the posterior claws the pectinate arm arises near the base of the inner arm and is only about half as long as the latter (these observations, made from two specimens carefully mounted on slides for high-power magnification, differ slightly from Terry's figures of the types—his types were also re-examined and agree with the above description). Each claw with a hyaline lanceolate lamella arising from base; a long spine arises from a prominent tubercle between base of claws and lateral lobe on each side; empodium large, pectinately plumose. Anterior and lateral surfaces of coxae with large setae on distal portion; trochanters with dense fine setae ventrally, legs sparsely clad with short fine hairs, the longest of these never longer than diameter of segment on which borne.

Abdomen with very sparse setae arising from light-colored ocellate integumental spots, most highly developed on anterior three tergites and all sternites, posterior tergites nearly bare. Male genitalia rotated variably to right or left. Basistyles stout, nearly as broad as long, tapering distally, concave dorso-mesally, with sparse short hairs laterally and fine setae mesally; dististyles flattened, ovoid, about twice as long as broad, folded mesad, and covered with fine setae which are directed proximad on the flexor surface. Phallosome directed dorsad from between bases of basistyles, consisting of a conical hyaline median cylinder with two rounded lateral distal lips, flanked by and fused on basal half with two hyaline sclerotized plates tapering and recurving anteriorly to a sharp point; phallosome connected at base dorsally with a pair of sclerotic plates forming a bridge with the dorso-mesal articulation of the basistyles, at point of connection a heavily sclerotized plate-like paramere extends well out into the interor of basistyle. A membranous wrinkled pubescent anal tube projects dorsally just anterior to base of phallosome.

Female.—Similar to male in size, coloration, vestiture, and general characteristics. Tarsal claws long and simple, not bifid. Eighth abdominal segment reduced, laterally compressed, and triangular in outline from side, about as long as high, the small blunt-tipped cerci borne apically on a line with the ventral margin of the sternites, and enclosing the dorsal valves of the ovipositor. The ventral valves open ventrad between the bases of the cerci; cerci and valves densely pubescent, eighth sternite with fine hairs especially ventrad, eighth tergite practically bare.

Larva.—Length mature, about 10-12 mm., head capsule 1.2 mm. long, 0.8 mm. wide. Color olivaceous green, head capsule sclerotized dark amber brown, black along cervical border, epicranial suture, and distal half of mentum and mandibles; hooks of pseudopods dark brown.

Head barrel-shaped, slightly flattened dorso-ventrally, shape seen from above oval, slightly tapering cephalad, region of clypeo-labrum narrowed bluntly snout-like and somewhat downcurved; integument with pebble-grained sclerotized thickenings. Frons narrowly shield-shaped, about two-thirds as broad as long, truncated anteriorly by fronto-clypeal suture which is over half as long as greatest width of frons, frons widest at about middle, tapering roundly caudad to a blunt point at junction of arms of epicranial suture. Post-clypeus distinct as a prominent transverse sclerite immediately anterior to frons; width about two-thirds the length of fronto-clypeal suture, about half again as wide as long; pre-clypeus a minute round median sclerite just anterior to post-clypeus. The lateral and cephalic margins of the clypeo-labrum are arched and continued ventrally in a prominent overhanging upper lip, the margins of which are strongly sclerotized, surface of this area with prominent peg-like integumental thickenings. Antennae borne laterally at level of fronto-clypeal suture, four-segmented; the basal segment about twice as long as broad, twice as broad as distal segments and about one and a half times as long as remaining distal segments together; second segment peg-like, slightly longer than broad, bearing the two minute distal segments and several minute spines distally, the basal segment also bears apically a membranous biramous Lauterborn's organ as long as and adjacent to combined distal segments. A pair of small irregular eyespots is situated on side of head behind antennae. Dorsally the head bears rather long hyaline setae as follows: two sublateral pairs just in front of preclypeus on each side; a pair from prominent tubercles just anterior to ends of fronto-clypeal suture; a pair in anterior corners of frons, a pair on lateral margins of frons about one-third way back; a pair just laterad of frons just caudad of widest portion; a pair on side of head just below antennae, and another pair at same level just below the eyespots.

Labrum folded downwards and emarginate, the cephalic margin bearing a variety of curved hooks, spines, pegs, and setae mesally and several tufts or combs of long flattened hairs at sides; the paired premandibles are borne

laterally on the ventral side, their flattened tri-dented apices directed mesad. The large heavily sclerotized mandibles bear five blunt blackened teeth on distal third, a stout hyaline appressed distally directed spine arises just proximad of these; a compact brustia of fine hairs arises near base on dorsal surface, and ventral side bears two long setae. Maxillae flattened, subquadrate in outline, with a large dorso-proximal sclerite bearing two stout setae and a second ventral sclerite bearing the short barrel-shaped unsegmented palpus on anterior margin; a hyaline membrane extending from the dorsal sclerite to under the palpus bears a beard of stout flattened spines, while a rounded distal membranous lobe from the ventral sclerite gives rise to a variety of pegs and spines and a distal beard of slender flattened hairs. Mentum arched triangular in outline, the median tooth broad with blunt angularly-pointed apex, six sharp progressively smaller and shorter lateral teeth counting a minute basal tooth on each side. Hypopharynx consists of a membranous lobe bearing a dense beard of long flattened hairs supported by two long slender sclerotized arms in a V-shaped bridge; near the apex of the V these arms are joined by a transverse sclerotized arm, a membrane between the basal arms of the bridge bears an even vestiture of fine flattened setae.

Prothoracic pseudopod shallowly bilobed, each lobe crowned with many brown hooks ranging from long slender slightly curved hooks on cephalic margin at apex to minute retrorse spines halfway up on caudal side of pseudopod. Thoracic segments with 6-10 pairs of lateral setae of varying sizes, abdominal segments I-VIII each with 2-3 pairs of small lateral setae. Ninth segment rounded dorso-posteriorly, indistinctly segmented into a ventro-posterior portion bearing the anus between a pair of stout pseudopods, these each with a mesally interrupted crown of about 17 stout curved black hooks at apex; surrounding the anus are an unpaired posterior and a pair of lateral blunt ovoid gills not quite as long as pseudopods. Dorsal portion of ninth segment bears a pair of prominent double long black hairs on posterior extremity and a few, scattered minute setae; each pseudopod bears two or three long hairs about halfway on lateral side.

Pupa.—Length, about 6 mm. Integument of cephalothorax sclerotized amber-brown, with pebble-grained thickenings and irregular transverse wrinkles. Thoracic respiratory organs of usual shape, spiracle small, opening dorsally about midway of lobe. A pair of large amber sublateral setae on dorsum of cephalic lobe, a pair just mesad of bases of respiratory organs, two submedian pairs about halfway between base of respiratory organ and midline, and a submedian prescutellar pair. Integument of abdominal tergites with rather coarse shagreening throughout, a brownish patch on seventh tergite just anterior to terminal disc; only a few scattered minute hairs on tergites and sternites. Terminal abdominal disc sclerotized amber-brown, rim with heavily sclerotized brown denticles; disc divided at upper fourth by a transverse slightly arched suture, the rim of the dorsal sclerite without hairs but face of sclerite with two pairs of long dark sub-lateral hairs. Denticles of ventro-posterior sclerite with numerous fine amber-colored hairs, except at extreme posterior apex which is smooth and bilobed and bears ventrally a pair of curved terminal spikes; face of posterior sclerite bears two pairs of long dark hairs in a submedian trapezoid. Face of shield rather smooth, not as rough as in other species. Trunk of eighth segment anterior to shield bears long brown hairs as follows: two sublateral pairs on anterior side of dorsal sclerite of disc near margin, two pairs at extreme tips of dorsal sclerite, four sublateral pairs on ventral margin of trunk of eighth segment anterior to genital lobes, a pair about halfway back near dentated margin of posterior sclerite of disc, and about eight pairs in a straggling line on each side of genital lobes to near apex of disc.

Material examined: Kauai: From the H.S.P.A. Exp. Sta. collection: 1 male, 1 female, Kilauea, Kauai, August 2, 1909. From

the Bishop Museum collection: 1 male, Kilauea, August 2, 1909, Terry, coll. Wirth collection: 1 male, 1 female, many larvae, 2 pupae, Kokee, Kauai (4000 ft.), September 6, 1946, W. W. Wirth (falls at tunnels into Kauaikinana stream); 1 male, 1 female, Kokee stream (3500 ft.), September 6, 1946, W. W. Wirth (at falls into Waimea Canyon). *Oahu:* 8 males, 2 females, 10 larvae, 1 pupa, Kaluanui Valley (2000 ft.), May 14, 1946, W. W. Wirth (above Sacred Falls).

T abnormis was taken in the mountain streams of the Kokee region on Kauai, where it occurred together with the much larger and more hairy *hirtus*. No unusual habits were noted for *abnormis*, while collecting the few Kauai specimens; the paucity of material collected was not due to its rarity, but to the great physical difficulty in gaining access to the falls and rapids of the streams draining the untraveled mountainous forests at the head of the rugged 2000-3000 feet deep Waimea Canyon. With the watershed receiving 500-600 inches of rainfall annually, the streams are large and numerous.

On Oahu, *abnormis* was collected from Kaluanui Valley above the famous Sacred Falls, probably the wettest locality on the island. It is interesting to note that in the adjacent Punaluu Valley, next toward Honolulu, two *Telmatogeton* specimens which were collected in an irrigation flume were *fluviatilis*, a species widespread in the Koolau Mountains. It is believed that *T. abnormis* is the ancestral form of fresh-water *Telmatogeton*; it is very close to the marine *japonicus* from which it probably was derived; in turn the Oahu species *fluviatilis* and *williamsi* differ but slightly from *abnormis*, while *torrenticola* and *hirtus* are further removed.

The male tarsal claws of *abnormis* are not as figured by Terry, the claws of all legs being alike with the anterior claws bifid at about halfway, the posterior claws bifid near base, in this respect resembling *japonicus*. Other useful characters of *abnormis* are the gradually tapering, rather short seventh antennal segment; normal vestiture, wing venation and male genitalia; bluntly tapering female genital segment; small anal gills sometimes present in the larva; and the extensive shagreening of the preapical abdonimal segments of the pupa, especially the seventh tergite.

Group B

6. **Telmatogeton japonicus** Tokunaga.

Telmatogeton japonicus Tokunaga, Philippine Jour. Sci., **51**: 95, 1933 (Japan; male, female; seashore between tidemarks); *idem*, **57**: 491, 1935 (description and figures of immature stages; biology); Biogeographica 2: 38, 1937 (additional Japanese records).

Male.—Length of body, 3-4 mm.; wing, 2.5-3.5 mm.; breadth of wing, 0.6-0.8 mm. General color brownish black, thorax and abdomen pruinose; head, humeral angles of mesonotum, pleura, scutellum, legs and genitalia brown; wings smoky brown; halteres pale brown.

Antenna (fig. 5a) 7-segmented; basal segment large, subcylindrical, about as long as broad, its diameter about twice that of distal segments, with many long setae; segments 2 to 7 of about equal diameter; second segment about twice as long as broad, constricted at middle; segments 3 to 6 subspherical; apical segment about two and a half times as long as wide at base, tapering on distal half to a rounded tip about half the diameter of proximal portion, tip darker than proximal portion; distal six segments without setae except one or two at base and a very fine hair at tip of seventh segment; entire antenna densely pubescent, distal six segments with numerous sensory pits; ratio of lengths of antennal segments, beginning proximad, 30:25:10:10:10:10:27. Maxillary palpi (fig. 5b) two-segmented, setigerous, the proximal portion bulbous, distal portion about half as broad, thumb-shaped, occasionally the segmentation incomplete. Paraglossae small, oval, setigerous. Posterior edge of clypeus and posterior border of eyes with long black setae.

Lobes of pronotum with three to five setae. Mesonotum large, with 3-5 setae in each subdorsal row, a row of 2-6 setae above wing base, and from 2-10 setae in a pre-scutellar patch, all these setae long and black and arising from light-colored integumental spots. Scutellum with 20-30 long setae, these about as long as the length of scutellum; postscutellum without setae; pleura also bare.

Wings with radial veins infuscated; numerous short spines along costa, about 13 spines on R, 2 on R_1, and about 7 on R_{4+5}; other veins bare; a fringe of short fine hairs on posterior margin from anal angle to tip; squama fringed with about 25 long hairs. R_1 short, entering costa at a little less than half the length of R_{4+5}, which is gently curved, entering the costa slightly before wing-tip; M almost straight, very slightly sinuous; Cu downcurved at base, Cu_1 curved, reaching wing-margin half-way between ends of M and Cu_2; Cu_2 curved strongly at apical three-fourths to meet wing-margin at right-angles; cross-vein r-m oblique, base before middle of wing; fCu slightly distad of base of r-m. Relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 8:4:9:7:11 respectively.

Legs long; relative lengths of segments from coxa distad, 3:1.2:10.5:10:5.5:3:1.2:1.1:1.8 on front legs, 3:1.2:16:11.6:4.5:2:1:1:1.8 on middle legs, and 3:1.2:15.5:11.5:6:3.2:1.2:1.1:1.7 on hind legs. Coxae large; trochanters simple; front femora markedly clavate at base, posterior femora slenderer; apical tibial spines one on fore and middle legs, two on hind legs, pubescent at base, bare apically. Last tarsal segment (fig. 5c) deeply trilobed, lateral lobes about a third as long as median lobe, which is about twice as long as wide; empodium large, pectinately plumose. Tarsal claws alike on all legs, unevenly bifid; the anterior claws of each leg bifid at distal three-fourths with the pectinate outer process about twice the length of the sharp inner process; the posterior claws bifid at proximal third, the pectinate lateral process about half the length of the long sharp inner process. Each claw with a lanceolate hyaline lamella arising mesad at base; a long spine arises from a long tubercle laterad of each claw between lateral and median tarsal lobes. Anterior surfaces of coxae, trochanters, and all of femora, tibiae, and tarsi setigerous; those of coxae particularly large and dense, and setae of all femora, tibiae, and tarsi relatively long, about as long as diameter of tarsal segments.

Abdomen sparsely covered with setae, those of tergites I-IV much longer; light-colored ocellate spots at bases of setae arising near pleural sutures. Male genitalia rotated variably; basistyles stout, truncated, with a small setigerous lobe on mesal side near base, with long setae ventro-laterally becoming very small and fine on dorso-mesal surface; dististyles oval, flattened, with fine setae, these directed proximad on flexor surface; phallosome conical,

directed dorsad from between bases of basistyles, closely guarded by a pair of hyaline sclerotized plates with which it is fused on basal two-thirds; connected at base with a pair of sclerotized hyaline plates which in turn articulate with the dorsal articulation of the basistyles and the proximal ends of the prominent internal parameres. Anal tube prominent, membranous, arising at base of eighth tergite.

Female.—Similar to the male with the following differences: Wing broader than in male and may or may not reach tip of abdomen. All tarsal claws long, pointed, simple, not bifid. Eighth abdominal segment triangular in outline, about half again as long as high, tapering, laterally compressed; cerci long, ovoid and pubescent.

Larva.—(from Tokunaga, 1935) Color semi-hyaline pale-green to greenish-brown, setae of body reduced. Head flattened subcylindrical with narrowed anterior nose-like projection, color brown, darkened along occipital foramen, cephalic margin, lateral margins of front, and base of mentum; integument with pebble-grained thickenings. Eyespots present and irregular. Antennae small and four-segmented, proximal segment stout, about twice as long as broad and subequal in length to remaining distal segments; second segment twice as long as wide, third and fourth minute; a biramous membranous Lauterborn's organ as long as distal three segments combined borne at apex of proximal segment; second segment also bears a number of minute apical sensory spinules. Frons broad and shield-shaped, with two pairs of small setae near the anterior corners along the lateral margins. Vertex with a pair of lateral setae behind antennae and a pair along frontal suture just behind widest point of frons. Clypeo-labrum with a small median posterior transverse post-clypeal sclerite and a very small semicircular pre-clypeal sclerite; the lateral and cephalic margins strengthened and roundly arched ventrad in an overhanging lip; three pairs of long sub-lateral setae on dorsal aspect.

Extreme cephalic margin of labrum with a variety of stout pegs and spines mesally and a pair of lateral brushes of fine fringed hairs; a pair of stout premandibles with flattened tri-lobed apices are articulated on ventral face of labrum. Mandibles stout and heavily sclerotized, with seven sharp darkened teeth on distal third; a stout hyaline distally-directed appressed spine arises near proximal tooth; a compact brustia of about six long hairs near base on dorsal face and two long hairs on ventral face of each mandible. Maxillae triangular, the mesal apex with a beard of long setae and fine hairs, the short unsegmented palpus borne about midway on anterior margin, the margin laterad of palpus fringed with close-set stout pointed spines; the ventral surface of each maxilla with three pairs of long setae. The hypopharynx consists of a transverse lobe with a dense apical fringe of long feathered hairs supported by two long narrow sclerotized arms forming the arms of a V. The mentum is dark and highly sclerotized, 11-toothed, the median tooth largest (relatively small and sharply pointed compared with other species), the lateral teeth becoming progressively shorter and smaller.

Thorax and abdomen with the setae minute, except for the two pairs of long caudal setae on the ninth segment. Anterior pseudopod shallowly bilobed, each lobe with the usual apical crown of narrow hooks. Posterior pseudopods each with 19 stout curved simple hooks in three irregular rows at apex. Anal gills lacking.

Pupa.—(after Tokunaga, 1935) Of the usual shape for the genus with the following specific characteristics: Head not distinctly bilobate, with a pair of prominent setae arising mesad of bases on antennae. Prothoracic respiratory organs broad and flattened, curved and tapering to tip, with the small spiracle dorsally situated near lateral margin at proximal third. There is a pair of anterior setae and two pairs of posterior setae just mesad of the respiratory horns; a pair of setae just mesad of wing bases, and two pairs of minute and one pair of larger submedian pre-scutellar setae. Each of the

first seven abdominal tergites and sternites with several minute setae, a large oval brown shagreened area present on third sternite, and small shagreened patches at the caudal ends of the U-shaped sclerotized lines on segments III-VI. The flattened terminal abdominal disc is rounded, slightly oval in outline, more so in the female, with transverse arcuate suture at the upper fourth. The dorsal sclerite bears many coarse denticles on the rim and four long submarginal hairs on the face; the posterior sclerite bears a fringe of many fine hairs on the thickened margin except at extreme caudal fifth, which is bilobate and bears two strong ventral spines; there are two pairs of long hairs in a submedian trapezoid on the face of the posterior sclerite with two short longitudinal infuscated lines between them. The face of the dorsal sclerite of disc is covered with minute pits and the posterior sclerite is densely covered with minute spinules and scattered spines. The unspecialized portion of the eighth segment is provided ventrally with five pairs of setae along its posterior border laterad of the genital lobes in the male, three pairs in the female; there are two pairs of sublateral setae and two pairs of setae at the extreme lateral ends of the dorsal sclerite of disc on its anterior side; the ventral side of the posterior sclerite bears seven scattered long hairs on each side of the genital lobe in the male, eight in the female. There are four small setae at the base of the female genital lobes, those of the male are bare.

Material examined: 1 male, 1 female, Hilo, Hawaii, December 19, 1945, light trap; 42 males, 10 females, Hilo, Hawaii, February 27, March 2, 6, 1946, W. W. Wirth (scampering over wave-drenched boulders on bay-front at park).

The Hawaiian specimens agree closely in every character studied with Tokunaga's excellent descriptions and figures of *T. japonicus,* and it can only be concluded that this Japanese species, like *T. pacificus,* enjoys a wide distribution across the central Pacific. It is particularly interesting to note that the marine Hawaiian *Telmatogeton* are related to the Oriental species rather than to the Australasian counterparts, *T. australicus* from Australia and *T. pusillum* from the Marquesas Islands. There is a distinct possibility, due to short descriptions, which cannot be resolved without examination of the types, that *pusillum* may be the same as *pacificus.*

The Hilo material was collected from boulders on the bay-front in a limited area near the outlet of a large storm-sewer, with a heavy growth of the algae *Ulva* sp. and *Enteromorpha* sp., indicating that the water was of considerably lower salinity than pure sea water. Since Tokunaga (1935) found *japonicus* always associated with the algae *Ulva pertusa, Enteromorpha compressa,* and *Monostroma* sp. on the Japanese coasts, and his excellent detailed biological account of its habits there checked with all of the limited observations made by the writer on the Hilo examples, there is abundant confirmation for the morphological identity of the Hawaiian insects with *japonicus.*

That the Hawaiian *japonicus* is nocturnal is indicated by the capture of adults in a light trap operated several hundred yards inland from the beach; other adults were captured while resting on and scampering over the boulders at the hours of 4 to 5 P.M. and 8 to 9 A.M., the only times that collections were made. Other insects associated with *japonicus* on the algae-covered boulders

were *Scatella sexnotata* Cresson and *Canace nudata* Cresson (Ephydridae), *Cymatotopus acrosticalis* Parent (Dolichopodidae), *Dasyhelea calvescens* Macfie (Heleidae), and *Telmatogeton pacificus* Tokunaga, *Thalassomyia setosipennis* Wirth, and an undescribed species of *Clunio* (Tendipedidae).

7. Telmatogeton australicus Womersley.

Telmatogeton australicus Womersley, Rec. S. Australian Museum 5: 441, 1936 (Sellick's Beach, Noarlunga, So. Australia; male, female, larva, biology).

According to Womersley's description, *T. australicus* is quite close to *T. japonicus* from Japan and the Hawaiian Islands. The salient characteristics of *australicus* appear to be: 1) size moderate, length 3.0 mm., wing 4.0 mm.; 2) color brownish with lighter and darker markings as in *japonicus*, wings pearly gray; 3) antennae with last segment twice as long as broad at base, tapering to tip which is not marked off (Womersley's figure, however, shows the seventh segment rather oval and not tapering); 4) eyes large, surrounded with fairly long numerous setae; 5) mesonotum without discernible setae; scutellum with only 6 setae; 6) wings with fCu slightly distad of r-m, about 20 setae on radius, 6 on subcosta; 7) trochanters simple, femora clavate at base; 8) tarsal claws of male bifid almost to base (apparently from Womersley's figure the anterior and posterior claws are asymmetrical with the pectinate outer arm longer on the one, the sharp inner arm longer on the other), with adjacent membranous lanceolate plates, empodium long and plumose; 9) abdomen with sparse short hairs; 10) male genitalia as usual, of *japonicus* type. The most important characters which would separate *australicus* from *japonicus* are the reduction in setae on the thorax and scutellum, the shorter last antennal segment without darkened tip, and slight differences in the male tarsal claws in the Australian species.

The larva of *australicus* resembles others of the genus generally, size 4-5 mm. (? immature); color whitish green, head brown, highly sclerotized, non-retractile. Frons oval, widest before middle, with a pair of lateral subanterior setae; vertex with two setae and and an eyespot on each side at extreme lateral margin, also four pairs of pores situated along epicranial suture; clypeo-labrum dorsally with three pairs of setae; antennae four segmented, the first segment half again as long as wide, second similar but smaller, distal two segments minute; mandibles 5-toothed, mentum with 11 teeth, the median tooth broad; setae of body minute, last segment with the usual two pairs of long setae; anterior and posterior pseudopods of usual form.

Womersley remarks that *australicus* is a diurnal species, the adults appearing by the thousands on bright sunny days during the summer. They inhabit the outer portions of the reef which are

covered at high tide with about a fathom of water, the adults appearing at low tide, moving rapidly with a hopping movement over the mossy rocks and about the small pools.

Group C

8. **Telmatogeton simplicipes** Edwards.

Telmatogeton simplicipes Edwards, Dipt. Pat. & So. Chile, pt. 2, fasc. 5: 305, 1931 (Ancud, Chile; male; algae-covered rocks between tide marks, figures of male genitalia, antenna).

The following characters from Edwards: 1) length, 3 mm., wing 2.3 mm.; 2) head with only a few hairs at sides of frons, hairs around eyes short; 3) antenna with segment I not much longer than broad, hairy, II twice as long as broad, with two hairs near tip, III-VI without hairs but with several short stout sense bristles near tip; VII oval not twice as long as broad, scarcely narrowed toward tip, with two hairs near base; 4) thorax colored as in *trochanteratum,* only 6-8 subdorsal hairs and 3-4 supra-alar hairs; 5) legs with mid-trochanters simple, male claws all alike, bifid from near middle, pectinate outer arm longer than pointed inner arm; 6) wings with 12 hairs on radius; 7) male genitalia with basistyle narrow, apparently of the *pacificus* type, anal tube present.

The relationships of *simplicipes* are not clear. The antenna figured would not be close to any known species. The male genitalia is allied to that of *pacificus;* also the condition of the male tarsal claws. The condition of the empodium or the position of the cubital fork in relation to the cross-vein is not stated.

9. **Telmatogeton pacificus** Tokunaga.

Telmatogeton pacificus Tokunaga, Mushi, 8: 15, 1935 (Japan; female); Biogeographica, 2: 34, 1937 (male; Japan).

Telmatogeton pusillum Williams (not Edwards), Proc. Haw. Ent. Soc., 12: 166, 1944 (Oahu, Hawaiian Is.; notes on breeding habits).

Male.—Length of body, 2-3 mm.; wing, 1.2-2 mm.; breadth of wing, 0.4-0.6 mm. General color brownish; mesonotum with grayish pruinescence; in freshly preserved alcoholic specimens mesonotum with longitudinal space between subdorsal setae and sides caudad of a straight diagonal line about one-fourth way back dark brown, basal antennal segments, vertex, scutellum, postscutellum, tips of femora and bases of tibiae brownish, other parts pale brown; halteres, tibiae, and tarsi often yellowish-white; wings pale smoky brown; dried specimens darker with markings indistinct.

Head small, subspherical; eyes small and widely separated. Antennae (fig. 5b) 7-segmented, comparatively short, basal segment large, sub-cylindrical, slightly longer than broad, its diameter about twice that of flagellar segments, with many long dark setae; second segment about twice as long as broad, somewhat constricted in middle with two long setae; segments 3 to 6 sub-spherical, without setae; distal segment about twice as long as wide at base, suddenly narrowed distally to a small knob-like tip, with one long

seta; ratio of length of antennal segments beginning proximad, 30:30:11:11:11:11:25. Palpi (fig. 5e) elongated and incompletely segmented, constricted in middle, about four times as long as broad, with several scattered long setae. Paraglossae small, subcylindrical, about twice as long as wide, also constricted in middle. Clypeus and vertex dark, with many long black setae; also a circumocular ring of long black setae which curve to meet over the eyes.

Lobes of pronotum with one seta. Mesonotum strongly arched dorsally and overhanging the head anteriorly; about 7-10 long black setae in each subdorsal row and 3-6 setae in a supra-alar group, arising from prominent light-colored ocellate spots. Scutellum with about 10 long setae; the longest of these as well as the mesonotal setae are about as long as the length of the scutellum.

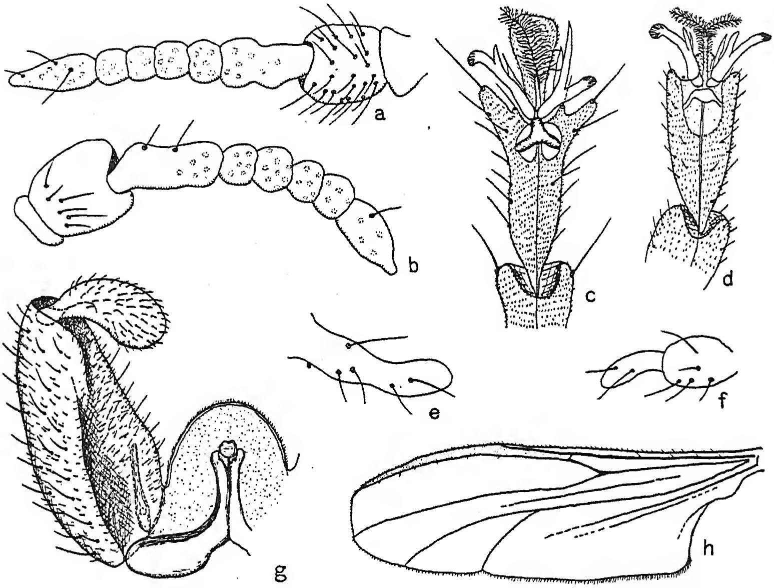


Figure 5. a) antenna, *T. japonicus;* b) antenna, *T. pacificus;* c) fifth tarsal segment of *T. japonicus,* ventral view; d) same, *T. pacificus;* e) palpus, *T. pacificus;* f) palpus, *T. japonicus;* g) male genitalia, *T. pacificus* (right basistyle removed, dorsal view); h) left wing, *T. pacificus.*

Wings (fig. 5h) appearing light smoky grayish brown; costa with close-set small spines for entire length; three long hairs on base of radius, about 9-10 spines on R_1, 11 on R_{4+5}; other veins bare. R and R_1 heavy, apparently continuous and straight, ending in costa about midway of wing; R_{4+5} gently curved, ending in costa just before wing-tip. M slightly sinuous, ending at lower edge of wing-tip; Cu_1 gently curved to meet wing-margin at a 55° angle; Cu_2 strongly curved to meet margin at right angles. Cross-vein r-m exceptionally far proximad, at slightly more than one-third the distance to wing-tip, thus fCu is much distad of r-m. Relative lengths of R and R_1 combined, R_{4+5}, base of M, and distal section of M, 34:28:20:33 respectively. Anal angle generally 90°, though in occasional specimens the anal angle is markedly obtuse, in these the wings are otherwise quite broad and rounding.

Legs long, relative lengths of segments from coxa distad, 2.5:1:7.4:6.8:4:1.6:1:0.9:1 on front legs, 2.3:1:11.2:7.6:3.8:1.4:1:0.8:1 on middle legs, and 2.5:1:10.6:7.6:4.2:2.2:1:0.8:1 on hind legs. Coxae large, trochanters simple, femora clavate at base, the front pair remarkably so and the posterior four but slightly; apical tibial spines small, single on all legs, pubescent at base, bare apically. Last tarsal segment (fig. 5d) trilobed, the lobes relatively short, especially the lateral pair which are scarcely perceptible. Tarsal claws alike on all legs, symmetrical, bifid at basal third, lateral tooth long and rounded pectinate at tip, inner tooth about half as long, slender and sharp. Each claw with a lanceolate hyaline lamella arising mesad at base; empodium bifid at distal half, plumose. Anterior surfaces of coxae, trochanters, and all of femora, tibiae, and tarsi setigerous, those on coxae denser and longer, others sparser and relatively short.

Abdomen sparsely covered with setae arising from light-colored ocellate integumental spots, those of anterior tergite quite long, progressively shorter on posterior tergites. Male genitalia (fig. 5g) turned through about 85°; basistyles relatively slender, widely separated at base by the phallosome complex, without lobe at base of dorso-mesal surface, with scattered hairs latero-ventrally and numerous short fine setae on mesal surface; dististyles short, oval, flattened, thickly covered with fine curved setae; phallosome large, projecting far dorsad, with a pubescent conical base ventrally and a small membranous anteriorly directed antero-dorsal lobe (as seen in deep fluid mounts); parameres slender, heavily sclerotized, directed into interior of basistyles. Anal tube not developed.

Female.—Similar to male, with following differences: Wing not nearly reaching tip of abdomen. All tarsal claws long and slender, much longer than those of male, simple and pointed. Eighth abdominal segment much narrowed and produced, the cerci long and slender.

Larva.—Length mature, about 7 mm.; head capsule 0.55 mm. long by 0.37 mm. wide. Color light greenish when mature, head capsule amber-brown, darker along cervical border and mandibular and labial teeth; hooks of pseudopods brownish.

Head barrel-shaped slightly flattened dorso-ventrally, lateral margins subparallel for most of length; integument of head with pebble-grained sculpturing, most pronounced in region of clypeo-labrum. Frons about twice as long as wide, widest at anterior third, anterior border truncated by the transverse fronto-clypeal suture which is about five-sevenths as long as greatest width of frons; frons roundly pointed caudad at junction of arms of epicranial suture. Clypeus transverse, apparently fused with labrum, the two forming a cowl which folds ventrad along a straight line on the anterior margin and is continued on the ventral side as the labrum. The antennae (fig. 6c) are small and borne laterally at level of fronto-clypeal suture; the barrel-shaped proximal segment is as long as distal segments combined, the second segment is about half as long and a third as broad as first and bears apically two minute distal segments and several minute sensillae adjacent to these; a slender membranous biramous Lauterborn's organ adjacent to and as long as the distal three segments together is also borne at the end of proximal segment. A pair of small eyespots is located laterally on head just behind antennae. The dorsum of the head bears small hairs as follows: a sublateral pair on anterior extremity of clypeo-labrum, a lateral pair at anterior corners of frons, a second pair on lateral margins of frons just behind level of eyespots; another pair adjacent to these across frontal suture; a lateral pair just ventral to eyespots; a pair just laterad of frontal suture about a third-way from caudal extremity of frons, a lateral pair just ventral to these, and a posterior pair situated well laterad about midway of the median arm of the epicranial suture.

Labrum, the dorsal aspects of which are discussed above, folded downward and caudad, the ventral portion greatly narrowed caudo-mesad, with very

heavily sclerotized emarginate lateral borders; a pair of long fine sublateral hairs directed antero-ventrad just below and mesad of the antero-dorsal pair mentioned above; a V-shaped row of about six setae-bearing tubercles mesad on the ventral margin; the paired flattened simple premandibles (fig. 6d) are borne laterad of and posterior to the lip, with the flattened tri-dented apices directed mesad. The mandibles (fig. 6b) are large, heavily sclerotized, with six teeth on distal half, two long ventral hairs and a brush of about six long hairs midway on dorsal margin. The maxillae (fig. 6a) consist of a simple flattened plate about three times as long as wide, bearing on the ventral surface beginning mesad a group of fine long slender combs directed toward the mentum, a group of blunt pegs, a short unsegmented palpus with a group of sensillae in the center of the truncated apex; two small hairs, a patch of small flattened setae at margin and one or two large hairs from a large tubercle near lateral margin. Mentum (fig. 6e) about as long as broad with a rather narrow long rounded median tooth, five sharp progressively smaller lateral teeth on each side. The hypopharynx consists of a small lobe thickly bearded with fine hairs, long flattened setae, and short spines supported by two slender heavily sclerotized arms in a V-shaped bridge.

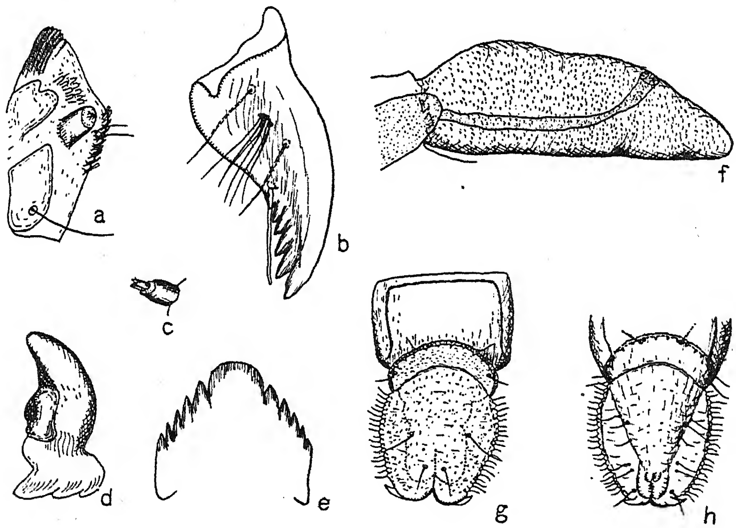


Figure 6. *T. pacificus,* larval and pupal details. Larva: **a)** left maxilla, ventral view; **b)** left mandible, dorsal view; **c)** antenna; **d)** premandible; **e)** mentum. Pupa: **f)** left prothoracic respiratory organ, dorsal view; **g)** terminal abdominal disc of male pupa, dorsal view; **h)** same of female pupa, ventral view.

Prothoracic pseudopods bilobed at tip, each lobe with a crown of many amber-colored hooks increasing in size from minute spines well up on posterior side of lobe to long slender curved hooks on anterior margin of apex. Thoracic and abdominal segments at most with a few minute hairs. Ninth abdominal segment rounded dorsally, indistinctly segmented into a ventro-posterior portion bearing the anus between a pair of short pseudopods; these each with a posteriorly interrupted crown of about 12-15 strongly curved hooks at apex; dorsal portion of ninth segment bears a sublateral caudal

pair of prominent double hairs. Hooks of both anterior and posterior pseudopods quite simple, without secondary teeth. Anterior pseudopods are retractile by inversion.

Pupa.—Length, about 3.4 mm. Color light, becoming darker as imago matures. Mesothorax arched antero-dorsally, a pair of prominent horn-shaped respiratory organs (fig. 6f) arising from humeral corners, projecting antero-dorsally over head, spiracle opening laterally at anterior third or fourth, the trachea within lobe slender and faintly marked; a long hair arises just mesad of the base of each antenna; two long hairs on humeral corner just dorsad of base of each respiratory horn, a long hair just anterior to each wing base, and two pairs of submedian hairs between wing bases.

Segments III to VI of abdomen with shagreened patches on anterior fourth of tergite and sternite within the bases of the U-shaped sclerotized lines, and at the posterior end of each lateral arm of the U; segments I-VII without evident hairs or setae. Terminal abdominal disc elongate (figs. 6g, 6h), about half again as long as wide, transverse suture at dorsal sixth of face of disc; dorsal portion with about 12 large sharp heavily-sclerotized denticles but without hairs; rim of posterior portion of shield with rounded evenly-spaced denticles each with a single long amber hair except at posterior extremity which is divided into two bare rounded lobes, each with a sub-apical ventral recurved hook. Face of dorsal sclerite of disc with a single long hair near rim at each lateral corner; posterior sclerite with four long hairs widely spaced in a sub-median trapezoid. Trunk of eighth segment anterior to the disc bears long black hairs as follows: a dorso-lateral pair near rim of disc; two hairs near each end of transverse suture of disc, a long hair on each side about halfway back near rim of posterior sclerite, and a row of four or five hairs just laterad of lobes of gonostyles.

Material examined: From the Bishop Museum collection: 4 males, Waianae, Oahu, November 2, 1935, F. X. Williams (on tidepool rocks). From the H.S.P.A. Exp. Sta. collection: 15 males, 4 females, Waimanalo Bay, Oahu, June 2, 3, 1936, F. X. Williams (algal tide rocks) (Note: 1 pin with 2 males, bears F. W. Edwards' determination label "*Telmatogeton ? pusillum* Edw." These very plainly have bifid empodia). Wirth collection: *Oahu:* 8 males, 1 female, Lanikai, December 29, 1945, W. W. Wirth (on rocks); 8 males, Hanauma Bay, January 4, 1946, W. W. W. (on rocks); 30 males, 20 females, Rabbit Island, August 30, 1946, W. W. W.; 3 males, 1 female, Makapu Point, January 5, 1946, W. W. Wirth; 50 males, females, Makapu Point, April 16, 1946, W. W. W.; Koko Head, February 11, 1946, 38 males, females, April 30, 1946, 50 males, females, 30 larvae, 6 pupae, August 27, 1946, 15 males, 5 females, 10 larvae, 1 pupa, all W. W. W. (on rocks with *Ectocarpus*); 8 males, Waimanalo, February 15, 1946, W. W. W.; 10 males, Kahuku, February 8, 1946; 30 males, females, Waimea, May 2, 1946, W. W. W.; 20 males, females, Waianae, August 28, 1946, W. W. W. (on rocks with *Ectocarpus*). *Hawaii.* 12 males, 5 females, Hilo, March 1, 1946, W. W. W. (on rocks Puumaile coast); 14 males, females, February 27, 1946, W. W. W. (on rocks, bay-front). *Kauai.* 50 males, females, Kilauea Bay, September 8, 1946, W. W. W. (on boulders on beach); 30 males, females, Nawiliwili Bay, September 7, 1946, W. W. W. (on wave-drenched boulders on waterfront and at light).

T. pacificus is found everywhere on the rocks of the Hawaiian seacoasts, the writer having taken it from ten widely distributed localities on Hawaii, Oahu, and Kauai. As stated in the excellent account by Williams (1944) who reported the first observations on this species under the name *pusillum,* it is most common at the upper tide belt on wave-drenched rocks and boulders characterized by a sparse growth of the tufted brownish alga *Ectocarpus* sp. Colonies were also found in bays as at Hilo, Hawaii, and Kilauea and Nawiliwili, Kauai, where a heavy influx of fresh-water from sizeable streams so freshened the shorewater in the bays as to promote heavy growths of the algae *Ulva* sp. and *Enteromorpha* sp. on the littoral rocks. Colonies of *pacificus* were most often found on the rocks and boulders of volcanic origin, but at Maile (Waianae) and Kahuku, Oahu, colonies were found apparently flourishing on wave-worn outcrops of coral rock underlying a narrow coastal plain. These coral outcrops were frequently interspersed with beaches of fine coral sand and supported a straggly growth of filamentous green alga (? *Enteromorpha* sp.). Tokunaga (1937) reports finding *pacificus* associated with the algae *Endocladia complanata, Nemalion pulvinatum,* and *Monostroma* sp. in Japan.

10. **Telmatogeton pusillum** Edwards.

Telmatogeton pusillum Edwards, B. P. Bishop Mus. Bull. **114**: 88, 1935 (Marquesas Is.; male, female; at light, presumably marine).

T. pusillum is apparently quite close to *T. pacificus,* points of similarity being their small size (wing 2 mm.), light brownish color, short lateral lobes of last tarsal segment, male claws bifid, symmetrical, sharp inner tooth of claw small, and cubital fork much beyond base of r-m.

From the Bishop Museum collection 2 male and 1 female specimens from Vaituha, Eiao, Marquesas Islands, (October 2, 1929, at light, A. M. Adamson, coll.) representing material collected with Edwards' types, were examined. As well as could be ascertained from the study of these pinned, dried specimens, the only differences between these and Hawaiian specimens of *pacificus* are the apparently simple empodium and the sharply bent vein Cu_2 in *pusillum.* The subdorsal setae of the mesonotum stated by Edwards to be "about 20 in each row" are actually 8 or 9 in each row as in *pacificus.*

Previous records of *T. pusillum* from the Hawaiian Islands should be referred to *T. pacificus* as all of about 500 adults taken at 10 scattered localities on Hawaii, Oahu, and Kauai, had the bifid empodium of *pacificus.* The specimens originally sent to Edwards for determination from Oahu were returned marked "*Telmatogeton* (?) *pusillum* Edwards." At present then, *pusillum* is known only from the Marquesas Islands.

Group D

11. **Telmatogeton sancti-pauli** Schiner.

Telmatogeton sancti-pauli Schiner, Novara Reise, Zool. **2**: 25, 1868 (St. Paul Is.; male, female described, larva and pupa figured); Edwards, Konowia, **7**: 236, 1928 (syn.: *Trissoclunio fuscipennis* Kieffer, n. syn.); Hesse, Trans. R. Ent. Soc. Lond., **82**: 27, 1934 (larva, pupa described, figured; ecology; South Africa).

Paraclunio fuscipennis Kieffer, Ann. So. Afr. Mus., **10**: 259, 1914 (So. Africa).

Trissoclunio fuscipennis Kieffer, Ann. So. Afr. Mus. **17**: 523, 1920 (type of *Trissoclunio* gen. n.).

Male.—Length of body, 4-5 mm.; wing, 5-6 mm.; breadth of wing, 1.6 mm. General color dark brown (blackish), most of body pruinose; humeral angles of mesonotum, pale brown, halteres yellowish; wings smoky brown.

Antenna (fig. 7a) 7-segmented, exclusive of the proximal ring-like antennaria; basal segment large, sub-cylindrical, slightly longer than broad, its diameter over twice that of distal segments, covered with many long setae; second segment about twice as long as wide, constricted in middle, the distal portion quite resembling one of the following four segments which are subspherical, each with a stout seta; seventh segment about three times as long as broad at base, tapering to tip, with three or four hairs at base; ratio of lengths of antennal segments beginning proximad, 60:40:16:16:16:16:50; entire antenna densely pubescent, apex of II, all of III to VI, and base of VII with numerous sensory pits. Palpi two-segmented, first segment small, variable in shape with a few distal setae; second segment oval, about twice as long as broad, densely setose. Paraglossae about size of distal palpal segment, ovoid, setose. Clypeus dark, with many quite stout long setae. Vertex dark, the setae sparse, but there is around each eye a ring of long stout hairs which curve to meet over the eyes forming a basket-like protection.

Prothoracic lobes small and widely separated, bare or at most with a few minute setae. Mesonotum large, broadly arched anteriorly overhanging the head; broad and flat between wings; setae of mesonotum small, arising from light-colored ocellate spots, restricted to a few (10) in each subdorsal row from humeral fossae to pre-scutellar space, and about 15-20 in a narrow patch above each wing-base. Pleura brownish-pruinose, bare of setae. Scutellum dark brown, convex, about twice as wide as long, with about 50 long dark setae, the longest of these about as long as length of scutellum.

Wings with costa, radius and base of M more darkly infuscated; costa with numerous minute setae its entire length, there are also a few scattered small setae on all branches of the radius; squama with a fringe of rather small hairs. Venation normal, fCu narrow, occurring at or slightly proximad of level of base of r-m; relative lengths of R, R_1, R_{4+5}, base of M, and distal section of M, 20:9:20:18:22 respectively.

Legs long; relative lengths of segments from coxa distad, 6:2.1:17:20:12:4:2.4:1.6:3 on front legs, 4:2.5:22:22:8:3.2:2.2:1.5:2.5 on middle legs, and 6:2.4:24:23:13.5:6:2.3:1.6:2.8 on hind legs. Coxae large, with a dense patch of stout setae distally, these are especially stout and spine-like on front coxae. Trochanters with a dense pad of short stout setae ventrally, the mid-trochanters are swollen with these setae borne on a ventral knob about as high as broad. Remainder of legs evenly clothed with short setae. Apical tibial spines one on each leg. Last tarsal segment (fig. 7d) trilobed, the lobes short, the median lobe not more than half the length of the claws when extended, the lateral lobes about two-thirds as long; empodium large, pectinately plumose from base between the claws. Tarsal claws unevenly bifid,

the lateral tooth pectinate at tip; on the anterior claws the pectinate arm is nearly twice the length of the sharp inner arm while on the posterior claws the sharp inner arm is slightly longer.

Abdomen with small hairs arising from light-colored ocellate spots, these hairs long on first tergite but reduced on other tergites and sternites. Male genitalia (fig. 7c) turned about 15° from horizontal plane and rather stout.

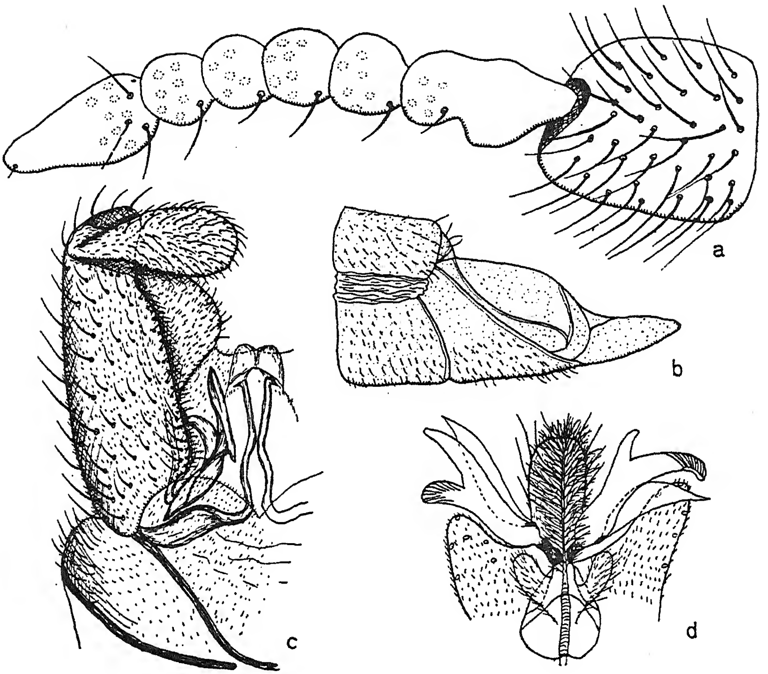


Figure 7. *T. sancti-pauli.* **a**) antenna; **b**) terminal segments of female abdomen, left lateral view; **c**) male genitalia, dorsal view (right basistyle removed); **d**) tip of fifth segment, right front tarsus, ventral view.

Basistyle about twice as long as broad, mesal face on dorsal side emarginate, the margin densely set with stout setae; the two basistyles fused mesally on ventral side on basal half or two-thirds, the part beyond gradually curved to apex. Dististyles simple, infolded, flattened, ovate, about twice as long as wide, widest on distal third, entire surface covered with fine hairs and pubescence. Phallosome complicated, mesally with two slender sinuous internal sclerotizations with hooked tips, a pair of adjacent long slender saber-shaped laminiform plates with a shorter curving lateral arm; all arising from a common sclerotized basal bridge which also gives rise to the internal parameres at the lateral basal corner of the lateral phallosomal plate. More or less ventral or posterior to the sclerotized parts there is a membranous anterior lobe rounded distally, and a longer hyaline posterior lobe rather truncate, indistinctly bilobed and with many minute teeth at apex. The area anterior to the base of the phallosome on the eighth dorsum is membranous and bears the indistinct membranous anal lobe.

Female.—Similar to the male with the following differences: Midtrochanters with ventral protuberance only about half as high as broad, the setae much smaller. All tarsal claws long, pointed and simple; last tarsal segment more deeply trilobed than in male. Eighth abdominal segment (fig. 7b) laterally compressed, tapering in side view and upcurved to a sharp point formed by the pointed cerci; bare except for fine setae on lower part of eighth sternite. The ovipositor is concealed within the cavity formed between the cerci.

Material examined: 1 male, 1 female, Mouille Point, Cape Town, So. Africa, September, 1933 (hatched from larva). Specimens kindly furnished by Dr. A. J. Hesse of the South African Museum, who published a very detailed study of the immature stages and ecology of this species in 1934. As no readily available description of the adults of *sancti-pauli* seems to exist (Schiner's [1868] was short and in German; Kieffer's [1914] in French) the above description was drawn up from Dr. Hesse's material.

As pointed out by Edwards (1931, p. 306) *sancti-pauli* is quite closely related to *trochanteratum* from Chile. Edwards did not mention it in his comparison, but the mid-trochanters of the male of *sancti-pauli* are enlarged and densely setose ventrally (first noted by Hesse, 1934, p. 36); however in *sancti-pauli* these projections are only about half as long as in *trochanteratum*. Further points of similarity are in the antennal segments III to VI which in both species bear one or two stout dorso-lateral hairs, rather exceptional in the genus; in the last tarsal segment of the male of both species are a pair of small pubescent lobes basad of each claw, the empodium is also plumose to base well proximad of bases of claws and the male tarsal claws are quite similar, at least on the front and middle legs. The most important points of difference are in the last antennal segment which bears a long terminal dark-colored nipple in *trochanteratum*, and in the weaker circum-ocular bristles, narrower basistyle of male genitalia, longer projection of mid-trochanter of male, and shorter vein R_1 in the Chilean species.

Hesse (1934) described the larva and pupa of *sancti-pauli*. The larva when mature measures 8-10 mm.; color various shades of olivaceous green, head brownish with tips of mandibles, eyespots, cervical margin of head, and hooks of posterior pseudopods black. Mandibles with 5 teeth; mentum triangular, the median tooth broad but with sharp-pointed apex, 4 or 5 teeth on each side. Head partially retractile within first thoracic segment; both anterior and posterior pseudopods retractile; anterior pseudopod with many narrow hooklets becoming small spinules posteriorly; posterior pseudopod with a posteriorly interrupted crown of large curved hooks distally; setae of body minute except for the pair of long double hairs at posterior extremity of ninth segment; no gills or spiracles present. The pupa measures 8-9.5 mm.; anterior cephalic margin with two convex rounded lobes, respiratory organs flattened, rather broadly expanded basally, gradually tapering to a blunt tip distally,

the lateral half indistinctly septate; spiracular opening oblique and slit-like, at proximal fourth of lobe. Preapical abdominal segments with a basal transverse shagreened area just behind base of sclerotized U on tergites and sternites, also a shagreened patch at the posterior tip of the lateral arms of the sclerotized U on third to sixth tergites and sternites. Terminal abdominal disc elliptical, more elongated in the female, divided by a transverse arcuate suture, the dorsal sclerite with strongly dentated rim, the posterior sclerite with the emarginate dentated rim bearing tufts of fine long yellow hairs from each tooth except at the bilobed apex, which bears ventrally a pair of curved spines. The face of the shield is heavily sclerotized and roughened, the dorsal sclerite bears two pairs of sublateral long black hairs, the posterior sclerite has two submedian longitudinal impressed smooth lines and two pairs of sublateral long black hairs. The under side of the disc also bears a number of long hairs, about four near each caudo-lateral edge of dorsal sclerite and about twelve laterally along each side of the median genital lobes.

Habitat.—On rocks covered with growth of the algae *Porphyra capensis* and *P. vulgaris* between tide marks, Atlantic and Indian Ocean sides of the Cape of Good Hope and on St. Paul Island, Indian Ocean. The larvae are transitional between the terrestrial and aquatic environments, and cannot stand permanent submergence, but require the moist protection of the periodically-drenched fronds of the algal food-plant. Hesse gives a very excellent discussion of the ecology of the immature stages in his paper.

12. **Telmatogeton minor** (Kieffer).

Paraclunio minor Kieffer, Ann. So. Afr. Mus., **10**: 260, 1914 (Mouille Point, Cape Town, So. Africa).

Trissoclunio minor Kieffer, Ann. So. Afr. Mus., **17**: 523, 1920 (from *Paraclunio*).

Telmatogeton minus Edwards, Konowia, **7**: 234, 1928 (from *Trissoclunio;* ? small form of *sancti-pauli*).

Telmatogeton minor Hesse, Trans. R. Ent. Soc. Lond., **82**: 34, 1934 (adults redescribed, figured; larva and pupa described, figured; ecology, So. Africa).

Excellent descriptions and figures of *T. minor* were given by Hesse (1934). A male and two females from Reef Bay, Port Elizabeth, South Africa, collected April 7, 1936 by T. A. Stephenson, were kindly furnished the writer by Dr. Hesse and used in determining the position of *minor* in the key to species at the end of this paper.

The most salient characters of *T. minor* are: 1) small size, body 4 mm.; wing 3-3.5 mm.; 2) extensive pale markings on the blackish brown base color; 3) antenna with basal segment short, seventh

segment short and tapering, apex not marked off; 4) setae of body and wings small and sparse; 5) mid-trochanters without marked protuberance in male; 6) apical tibial spines 1:1:2; tarsal ratio slightly over 0.5 on front and hind legs, much less than 0.5 on mid-legs, mid tarsi being quite short; 7) male claws bifid, anterior and posterior claws sub-equal, pectinate outer arm slightly longer than sharp inner arm in all claws; female claws simple; 8) empodium large, pectinately plumose; 9) wings pearly gray, not darkly infuscated; fCu at about level of base of r-m; 10) male genitalia of the *sancti-pauli* type; female abdomen markedly produced and tapering distally, eighth segment over twice as long as high, cerci long and narrow.

The larvae of *T. minor,* according to Hesse, are about 5 mm. long, quite dark in color (the body dark, the head shining black); the mentum has 11 or 13 teeth, the median tooth rounded; the distal mandibular tooth blunt; and the pseudopods are shown to be retractile but with the normal complement of hooks. The pupae (length 3.5-4 mm.) do not have the anterior cephalic margin bilobate as in *sancti-pauli,* the respiratory lobes are quite broad basally, abruptly tapering to tip with the spiracle at about proximal third; preapical abdominal segments without median shagreened area at bases of segments, but with quite broad lateral shagreened patches at the apices of the lateral sclerotized lines on tergites and sternites; terminal abdominal disc rather longer than broad, especially in the female, divided at dorsal sixth by an arcuate transverse suture, the border of the dorsal sclerite with fine denticles, the margin of the posterior sclerite with the denticles minute and furnished with tufts of very fine short yellowish hairs, the face of the disc not appreciably rugose or wrinkled.

13. **Telmatogeton trochanteratum** Edwards.

Telmatogeton trochanteratum Edwards, Dipt. Pat. & So. Chile, pt. 2, fasc. 5: 305, 1931 (Ancud, Chile; male, female; on seaweed-covered rocks exposed at low tides; figure of antenna, male genitalia and fifth tarsus).

Edwards' description and figure of *T. trochanteratum* are quite adequate to characterize the species: 1) length 2.5-4.5 mm., wing 3.3-5 mm.; 2) long dark hairs at sides of frons and around the eyes; 3) antennae dark except preapical portion of seventh segment whitened, first segment large and densely hairy, second long with two or three hairs near tip, segments III-VI subspherical each with one or two dorso-lateral hairs, seventh segment about twice as long as wide with three hairs near base and a deep subterminal constriction and a conspicuous darkened slightly swollen apical stylet; 4) mesonotum orange-yellow on shoulders and sides, brownish near wings and on scutellum, blackish pruinose mesad, 8-10 short subdorsal hairs, 6-8 short supra-alar hairs; 5) mid-trochanters of male

with a thumb-like projection fully twice as long as broad, rounded at tip, and pubescent, in female with a slight knob; 6) tibial spurs 1:2:2:7) tarsal claws of male bifid, anterior claws of front and middle legs with outer pectinate arm much longer than sharp inner arm, posterior claws with pectinate arm reduced, on hind legs the sharp arm is much longer than the pectinate arm on all claws; female claws simple; 8) wings with about 50 setae on radius, R_1 much less than half as long as R_{4+5}, membrane with hexagonal pattern of bare lines and with microtrichiae of two different lengths; 9) male genitalia not inverted, of *sancti-pauli* type, anal tube absent.

Allied to *T. sancti-pauli,* but differs as discussed under that species. It is interesting to speculate on how these allied species came to be separated at the southern extremities of two now widely separated southern hemisphere continents.

Key to the Species of *Telmatogeton*

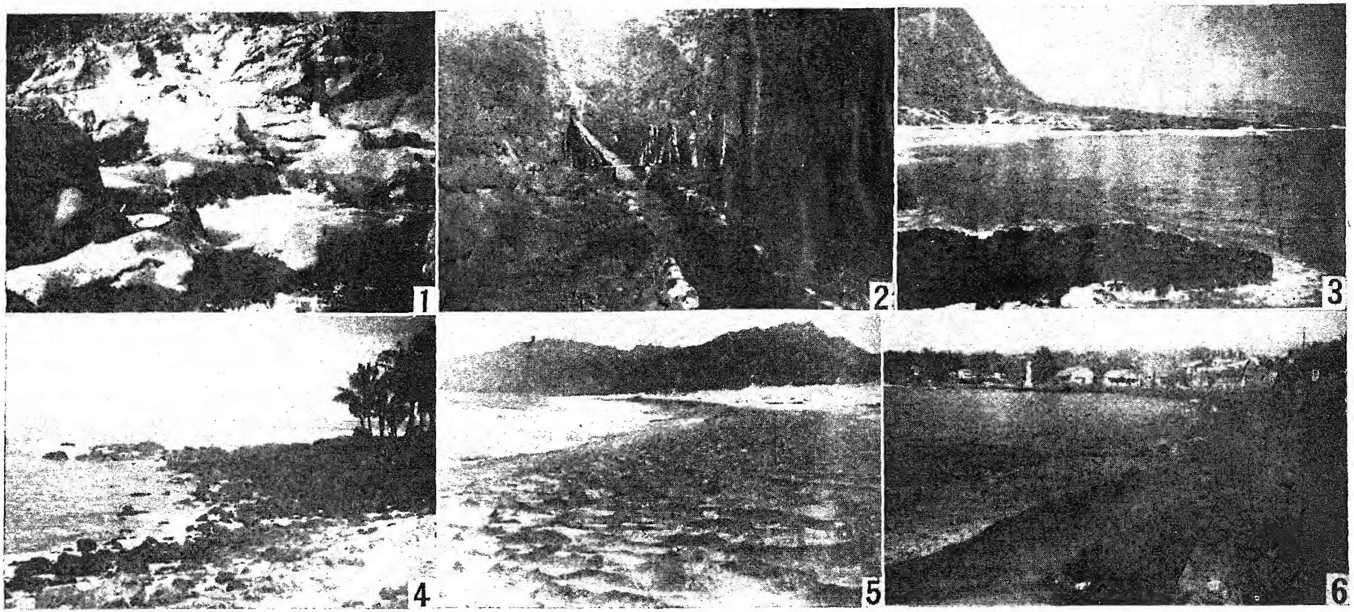
Adult Males:

1. Tarsal claws simple; not bifid, similar to female claws (fig. 1d)........ 2
   Tarsal claws bifid, each divided into a pectinate lateral arm and a sharp pointed inner arm (figs. 2, 4, 5, 7)........ 3
2. Hairy vestiture of entire body, especially the legs, remarkably dense and in the male quite long (hairs of legs 2-6 times as long as diameter of tarsi) (fresh-water; Kauai,—Hawaiian Islands) ....**hirtus** sp. n.
   Vestiture normal, short (fresh-water; Hawaii, Maui, Molokai,—Hawaiian Islands)........**torrenticola** (Terry).
3. Claws symmetrical, anterior and posterior claws of each leg similar (figs. 4d, 5d)........ 4
   Claws asymmetrical, anterior and posterior claws of each leg dissimilar (figs. 2c, d, e; 5c; 7d)........ 7
4. Claws with pectinate arm much longer than sharp inner arm........ 5
   Claws with pectinate arm much shorter than inner arm (fig. 4d) (fresh-water; Oahu,—Hawaiian Islands)........**fluviatilis** sp. n.
5. Last antennal segment narrowed to a terminal nipple-like tip (fig. 5b); cross-vein r-m much proximad of middle of wing (fig. 5h); lateral lobes of fifth tarsal segment short, less than half the median lobe (fig. 5d)........ 6
   Last antennal segment oval, scarcely tapering to tip; cross-vein r-m at about middle of wing; lateral lobes of fifth tarsal segment longer, at least half the median lobe (marine; Chile)........ ....**simplicipes** Edwards.
6. Empodium bifid at tip (fig. 5d); vein Cu_2 only gently curved (marine; Japan, Hawaiian Islands)........**pacificus** Tokunaga.
   Empodium simple; vein Cu_2 sharply bent and recurved (marine; Marquesas Islands)........**pusillum** Edwards.
7. Anterior claws with pectinate arm at least a third as long as the sharp inner arm........ 8
   Anterior claws with pectinate arm reduced to a basal knob, posterior claws with sharp inner arm small, arising three-fourths way on the side of prominent pectinate arm (fig. 2c, d, e) (fresh-water; Oahu,—Hawaiian Islands)........**williamsi** sp. n.

8. Antennal segments III-VI each with one or more dorso-lateral hairs (fig. 7a); mid-trochanters ventrally with a densely pubescent knoblike projection (in female with a slight raised knob)...... 9
   Antennal segments III-VI without hairs; mid-trochanters not swollen ventrally, simple........ 11
9. Projection of mid-trochanters at least twice as long as broad; last antennal segment with nipple-like tip about as long as basal part of segment; circum-ocular bristles not strong (marine; Chile) ....**trochanteratum** Edwards.
   Projection of mid-trochanters about as long as broad; last antennal segment tapered at tip, nipple absent; circum-ocular bristles strong, meeting over eyes........ 10
10. Large species (wing 5-6 mm.); color dark, mostly blackish, wings smoky brown; setae of body and wings numerous and strong (50 on scutellum); (last abdominal segment of female about one and a half times as long as high [fig. 7b]) (marine; So. Africa, St. Paul Is.)........**sancti-pauli** Schiner.
    Small species (wing 3-3.5 mm.); color light, mostly brownish, wings pearly gray; setae of body and wings sparse and small (12 on lateral edges of scutellum); (last abdominal segment of female long and tapering, over twice as long as high) (marine; So. Africa)........**minor** (Kieffer).
11. Color brownish, median mesonotal stripes blackish, sides pale brown; 20-25 setae on radius........ 12
    Color mostly black, light brown markings on mesonotum confined to a small humeral area; wings dark smoky brown; 7-10 setae on radius, 30 setae on scutellum (fresh-water; Oahu, Kauai,—Hawaiian Islands)........**abnormis** (Terry).
12. Scutellum with 20-30 setae; mesonotum with 2-10 prescutellar, 3-5 subdorsal, and 2-6 supra-alar setae; first antennal segment with many large setae, last segment with tip darkened, two and a half times as long as broad (marine; Japan, Hawaiian Islands) ....**japonicus** Tokunaga.
    Scutellum with only 3 setae on each lateral margin; mesonotum without discernible setae; first antennal segment with six setae, last antennal segment twice as long as broad, tip not darkened (marine; So. Australia)........**australicus** Womersley.

Larvae:

1. Three short anal gills present........ 2
   Anal gills absent........ 3
2. About 17 hooks on posterior pseudopods; setae of body reduced, abdominal segments each with 2-3 pairs of minute lateral setae ....**abnormis** (Terry) (in part).
   From 20 to 25 hooks on posterior pseudopods; setae of body well developed, abdominal segments each with 4 pairs of fairly long black setae........**hirtus** sp. n.
3. Posterior pseudopods each with at least 17 hooks........ 4
   Posterior pseudopods each with 12-15 hooks........**pacificus** Tokunaga.
4. Mandibles with 5 teeth........ 5
   Mandibles with 7 teeth (posterior pseudopods each with about 19 hooks) ....**japonicus** Tokunaga.
5. First segment of antenna short, about one or one and a half times as long as broad........ 6
   First segment of antenna about twice as long as broad........ 7



EXPLANATION OF PLATE

Fig. 1. Smooth rock bed of Wailuku River, above Rainbow Falls, Hilo, Hawaii, habitat of *T. torrenticola* (Terry). Fig. 2. Swift-flowing rock-lined ditch at Waianae, Oahu, receiving water from Mt. Kaala, habitat of *T. williamsi*, sp. n. Fig. 3. Rocky seacoast at Waimanalo, Oahu, habitat of *T. pacificus* Tokunaga. Fig. 4. Surf-drenched boulders on seacoast near Waimea, Oahu, habitat of *T. pacificus*, Tokunaga. Fig. 5. Sloping wave-polished coral beach at Maile, Waianae, Oahu, habitat of *T. pacificus* Tokunaga. Fig. 6. Algae-covered wave-washed boulders on shore of Hilo Bay, Hawaii, habitat of *T. japonicus* Tokunaga and *T. pacificus* Tokunaga.

6. Marine ....australicus Womersley.
Fresh-water species (posterior pseudopods each with 20-23 hooks) ....williamsi sp. n.
7. Median tooth of mentum broad and rounded distally.......................... ....torrenticola (Terry).
fluviatilis sp. n.
Median tooth of mentum narrow, pointed distally................................ ....abnormis (Terry) (in part).

(Position of larvae of *T. sancti-pauli* and *minor* uncertain in above key; larvae of *simplicipes, pusillum,* and *trochanteratum* unknown.)

Pupae:

1. Denticles of rim of posterior sclerite of terminal abdominal disc each with a tuft of many fine yellow hairs (fig. 3a, b)........................ 2
Denticles of rim of posterior sclerite of disc each with a single fine yellow hair (fig. 6g)..pacificus Tokunaga.
2. Anterior cephalic margin bilobate mesad; terminal disc of abdomen elongate, transverse suture at about dorsal sixth........................ 3
Anterior cephalic margin broadly rounded, not bilobate; terminal abdominal disc rounded, slightly ovate, suture at dorsal fourth...... 4
3. Spiracle at proximal fourth of respiratory lobe; preapical abdominal segments with basal areas of clear shagreening................ ....sancti-pauli Schiner.
Spiracle at proximal third of lobe; abdomen without shagreening on basal portion of segments..minor (Kieffer).
4. Preapical abdominal segments with a prominent patch of yellowish brown shagreening on one or more segments.. 5
Abdominal shagreening fine and colorless..........................williamsi sp. n.
5. Seventh abdominal tergite anterior to disc without large brown shagreened patch 6
Seventh abdominal tergite with a large brown shagreened patch covering most of tergite; spiracle about midway of lobe................ ....abnormis (Terry).
6. Third abdominal sternite with a prominent brown shagreened patch midway of basal sclerotized line; first tergite without large brownish shagreened area; abdominal vestiture of minute hairs.... 7
Third sternite without brown shagreened patch; first tergite almost covered with brown shagreened area; abdominal vestiture of prominent black hairs; (terminal disc with two prominent brown longitudinal impressed lines)..hirtus sp. n.
7. Face of terminal abdominal disc with rough pebble-grained sculpturing and a median area of fine tubercles or spinules...................... 8
Face of terminal disc without pebble-grained sculpturing or tubercles, quite smooth; rim of disc lightly sclerotized caudad................ ....fluviatilis sp. n.
8. Fresh-water species; about 10-13 hairs in submarginal area on ventral side of disc on each side of genital lobes.............................. ....torrenticola (Terry).
Marine species; about 7 hairs on ventral side of disc on each side of genital lobes..japonicus Tokunaga.

(The pupae of *T. australicus, pusillum, simplicipes,* and *trochanteratum* are unknown.)

Acknowledgments

The writer wishes in particular to thank Dr. F. X. Williams of the Hawaiian Sugar Planters' Association Experiment Station in Honolulu for his constant encouragement and valued aid both in the field and in the museum during the present study. Mr. E. C. Zimmerman of the Bernice P. Bishop Museum has kindly permitted the study of material in the Museum collections. Dr. L. G. Saunders very generously furnished material of *Paraclunio alaskensis* for comparison and Dr. A. J. Hesse also kindly furnished specimens of South African *Telmatogeton*. The author is indebted to Dr. John Smart for checking Hawaiian specimens of *T. pacificus* in the British Museum. Dr. Alan Stone of the U. S. National Museum has also offered several valued opinions on taxonomic problems.

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A New Phanerostethus from the New Hebrides (Coleoptera: Curculionidae)

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(Presented at the meeting of December 9, 1946)

It is always of interest to add to our knowledge of the geographical distribution of any group of organisms, and it is with considerable satisfaction that I record the presence of the cryptorhynchine weevil genus *Phanerostethus* Marshall, 1931, in the New Hebrides. The genus is now known to occur in the Society Islands, Samoa, Fiji, New Caledonia and the New Hebrides. In these *Proceedings,* 11 (2) : 235, 1942, I gave a check list of the seven described species and a map showing their distribution.

Phanerostethus laffooni, new species (fig. 1).

Male. Derm reddish brown to black; scaling dense, appressed, concealing most of derm, almost entirely black except as follows: a conspicuous white patch between eyes; pronotum with a white, median, prescutellar patch, scales on extreme base (ventral part abutting elytra) with a brownish cast rather than black; scutellum with white scales; elytra with basal part of second intervals white scaled, a patch of white just before middle on interval seven, subapical callosities white scaled, and with a few inconspicuous paler or white scales elsewhere; legs with some white scales on bases of femora and apices of tibiae; mesosternal side pieces with white or pale scales; metasternum and abdomen with pale scales, brownish, whitish and white intermixed, pale scaling on metasternum extending laterally between coxae to elytra; setae black, brownish and white, femora with white setae predominating.

Head with scales on crown small, dense, honeycomb-like in arrangement, white scales between eyes large, flatly imbricated; interocular area depressed, with prominent, erect, subspindle-shaped setae along inner margins of eyes.

Rostrum with about eight rows of prominent, robust, erect, mostly clavate or subspatulate setae borne from coarsely punctured striae from base to antennal insertions; bare, alutaceous, closely punctured from antennae to apex; subequal in breadth at apex, and at interoccular area, breadth at antennal insertions 10/11 that at apex.

Antennae with scape clavate, fully as long as first five funicular segments; first funicular segment not quite as long as following two combined, about twice as long as broad, about one-third broader than two; segment two about as long as three plus one-half of four; segments three and four subequal in length; five to seven successively broader; club somewhat longer than four preceding segments.

Proc. Hawn. Ent. Soc., Vol. XIII, No. 1, May, 1947.

Prothorax about as long as broad, broadest at middle, expanded from base to middle and arcuate to the well-marked subapical constriction which is continued broadly across dorsum whose longitudinal dorsal contour is conspicuously sinuous; extreme base rising abruptly, and nearly vertically, well above base of elytra, dorsal contours of pronotum and elytra abruptly discontinuous; punctures coarse, close, their interstices forming a reticulate pattern where exposed by abrasion of scales; squamae giving an incrustation-like appearance, excepting those in median, basal white patch which are larger and more discrete; setae conspicuous, erect, stout, peg-like, clavate or subclavate, numerous overall.

Elytra (measured from side) four units long as compared with two and one-half for prothorax, three units wide at widest part in basal quarter; base subtruncate, subcordate in lateral outline, strongly convex in longitudinal dorsal outline, highest at about basal three-eighths and there not as high as highest point on pronotum; subapical calli moderately well developed; striae well defined, coarsely punctured basad, more deeply impressed basad, thus giving intervals a more convex appearance there, striae six and seven not reaching base, ten not reaching middle of metacoxa; all intervals with a single row of prominent erect setae similar to those on pronotum, or somewhat longer, excepting interval two which has a double row beginning at about summit and running not quite half way down declivity, the interval more elevated and more convex in this region, intervals three and four distinctly nodiform at extreme base and with two and four less distinctly protuberant in holotype, interval one less convex than others in basal half; squamae appressed, giving an incrustation-like appearance.

Legs densely squamose and with numerous erect and slanting setae; inner sides of tibiae on male holotype with numerous hair-like setae, somewhat more conspicuous on fore pair.

Sternum with pectoral canal densely squamose in prosternal section, almost entirely bare between fore and mid coxae, squamose only at sides behind fore coxae; mesosternal receptacle with side walls high and well developed, but sloping back to level of metasternum at middle, densely squamose on outer sides and margins bearing conspicuous, sublanceolate setae, terminating at about middle of mesocoxae in male holotype; metasternum broadly concave, densely squamose and setose, as long along median line as abdominal segments three plus four.

Venter densely squamose, scales mostly moderately large and individually distinct, not closely appressed as on dorsum; setae numerous, conspicuous and scattered on ventrites one, two and five, mostly indistinct on three and four, longer, decurved and especially distinct on disc of one which is broadly and distinctly concave in male holotype, almost as long along median line as ventrites two to four inclusive plus about one-third of five.

Length: 3.25 mm.; breadth: 1.5 mm.

New Hebrides. Holotype male collected on Espiritu Santo Island, "VI-VIII-1944," by Jean Laffoon while on duty with a United States naval force in the New Hebrides; deposited in Bishop Museum.

This species is distinctly separated from the only other two species in the genus with which it might be associated because of its black scaling—*niger* Zimmerman from New Caledonia and *vitiensis* Zimmerman from Fiji—because of a number of well marked differential characters. The conspicuous, irregular, longitudinal, dorsal contour alone will serve to separate this species from *niger*. The contour is rather similar to that of *vitiensis*, but the different color

pattern of the dorsal scaling will serve as an easily seen character to separate these two species. The white basal patch on the pronotum, the lateral submedian white patches on the elytra and the white subapical calli stand out plainly against the black background scaling, even to the naked eye. The setae on the second elytral intervals tend almost toward forming a very loose, vague, elongate fascicle, because of their greater numbers. Those on the fourth interval also vaguely suggest condensation.

It gives me much pleasure to dedicate this fine new species to Jean Laffoon in recognition of his active interest in collecting in the New Hebrides and for his generous gifts of specimens to Bishop Museum.

NEW INSECT RECORDS FOR THE YEAR 1946

Species marked with an asterisk were reported in the Hawaiian Islands for the first time in 1946, on the dates recorded in the text. Those not so marked were observed here prior to that year, but have only now been identified or recorded. For particulars refer to the pages indicated.

CHANCE IMMIGRANTS

BENEFICIAL INSECTS PURPOSELY INTRODUCED

PROCEEDINGS OF THE Hawaiian Entomological Society

VOL. XIII, No. 3 FOR THE YEAR 1948 MARCH, 1949

JANUARY 12, 1948

The 505th meeting was held at the H.S.P.A. Experiment Station on Monday, January 12, at 2:00 p.m., with President Fullaway in the chair.

Members present: Balock, Bianchi, Bonnet, Fullaway, Holdaway, Keck, Krauss, Lewis, Look, Mainland, Pemberton, Ritchie, Rosa, Sakimura, Swezey, Tanada, Tuthill, Van Zwaluwenburg, Weber and Zimmerman.

NOTES AND EXHIBITIONS

Erebus odora (L.)—Mr. Krauss reported that a specimen of this agrotid moth, the black witch, was collected at Haiku, Maui on August 4, 1929; this is the first record for that island. The moth was first found in the Islands at Honaunau, Kona, Hawaii by A. C. Mason, October 15, 1928. Other first records are: Oahu, November 7, 1928; Kauai, January 27, 1929, and Molokai, April or early May, 1929. There are no published records of this species for Lanai or Niihau. The late Bro. Matthias Newell once said he had observed what was probably this moth at Hilo, Hawaii, some years prior to 1928.

Opsius stactogallus (Amyot)—Mr. Krauss exhibited this cicadellid leafhopper taken on tamarix at Keomuku, Lanai, October 28, 1947, and on the same host near Paia, Maui, November 12. These are both new island records. The species was first taken in the Islands on Oahu in June or July, 1928, and was later found on Molokai (1943) and Kauai (1944).

Stragania robusta (Uhler)—Mr. Krauss exhibited specimens of this North American cicadellid (determined by Dr. Swezey) taken at La Perouse Bay, Maui, November 11, and at Waihee, Maui, November 12; this is a new island record. This insect, formerly known as *Bythoscopus robustus,* had earlier been found at Kawela Bay, Oahu, April 23, 1933, and on Molokai, June 4, 1943.

Opius bred from *Eutreta*—Mr. Fullaway reported breeding the braconid *Opius tryoni* Cameron from galls of the lantana tephritid fly, *Eutreta xanthochaeta* Aldrich. He added that Q. C. Chock in the Philippines, bred an undetermined species of *Opius* from hau buds (*Hibiscus tiliaceus*) infested by tephritids of the genus *Acidoxantha.*

New species of Hawaiian *Clunio*—Mr. Van Zwaluwenburg called attention to a paper by Alan Stone and W. W. Wirth (Proc. Ent. Soc. of Washington, **49**: 201-224, 1947) in which are described three new tendipedid flies from Hawaii: *Clunio littoralis, C. vagans* and *C. brevis*.

Dacus dorsalis Hendel—Dr. Ritchie reported the presence of this fruitfly on Guam. K. L. Maehler bred it December 19, from bananas grown near Agaña.

Scolia ruficornis Fabr.—Mr. Pemberton exhibited specimens of this scoliid. He said that this wasp is being introduced from Zanzibar to the Palau Islands to control the coconut beetle, *Oryctes rhinoceros* (L.), under direction of the Pacific Science Board, National Research Council, at the request of the Navy. Living material is being shipped by Harold Compere via New York to Honolulu, where the wasps are fed and sent on through Guam to the Palaus. Of four consignments made during November and December, 1947, two arrived here with all material dead. A fair number of wasps were alive in the other two lots. *Oryctes rhinoceros* causes great damage to coconut trees in the Palaus. In Zanzibar *S. ruficornis* is reported to parasitize the larvae of *Oryctes monoceros* Olivier and of *O. boas* Fabr.

FEBRUARY 9, 1948

The 506th meeting was held at the H.S.P.A. Experiment Station on Monday, February 9, at 2:00 p.m., with Vice-President Balock in the chair.

Members present: Alicata, Balock, Bianchi, Bonnet, Joyce, Kartman, Keck, Krauss, Lewis, Mainland, Nishida, Pemberton, Ritchie, Rosa, Stout, Swezey, Tanada, Tuthill, Van Zwaluwenburg, Weber and Zimmerman.

Visitors: Miss Constance Inada, Mr. John H. Fales.

It was unanimously voted to confer on Dr. Francis X. Williams honorary membership in token of his long service to the Society. Miss Constance Inada was nominated for membership.

NOTES AND EXHIBITIONS

Dacus dorsalis Hendel—Mr. Van Zwaluwenburg said that this fruitfly, though known from Kauai since the latter part of 1946, has until now never been reported from that island. The distribution records for this species in Hawaii now include the islands of Niihau, Kauai, Oahu, Lanai, Molokai, Maui, Kahoolawe[1] and Hawaii.

Mr. Look reported breeding *D. dorsalis* from persimmon fruits (*Diospyros kaki*) collected December 11 at Mountain View, Hawaii; this is a new host record.

New immigrant *Volucella*—Mr. Van Zwaluwenburg called attention to descriptions by Curran of two new syrphid flies recently

[1] Reported in December 1948, by E. C. Zimmerman.

found on Oahu, and obviously immigrants from America (Amer. Mus. Novitates, no. **1361,** Nov. 3, 1947); *Volucella dracaena,* first taken by Charles Hoyt, January 1, 1946 (Proc. Haw. Ent. Soc., **13**: 4, 6, 1947) on flowers of *Dracaena* and of *Hoya* in Honolulu; and *Volucella hoya,* first collected by Dr. Williams, March 3, 1946, on *Hoya* flowers in Honolulu. Among the type material of *V. hoya,* Dr. Curran records specimens from Oahu and Lower California; *V. dracaena* so far is known only from Honolulu. Mr. Pemberton said he had recently bred *V. hoya* from rotting breadfruit.

New thrips records—Mr. Look reported new host records for two species of thrips determined by Mr. Sakimura, from the island of Hawaii. *Heliothrips haemorrhoidalis* (Bouché) on taro leaves at Ahualoa; and *Isoneurothrips carteri* Moulton, on naio leaves (*Myoporum sandwicense*) on Mauna Kea at 4,000 ft. elevation. This latter species was breeding within old tunnels of a leafminer, and was associated with *Haplothrips rosai* Bianchi and the eulophid, *Thripoctenus brui* Vuillet.

Mr. Krauss reported new island records from thrips collected by him on Lanai (October-November, 1947); Molokai (November 3-5); and Maui (November 7-15). Identifications were by Mr. Sakimura.

Lanai

Chirothrips mexicanus Crawford (Lanai City)
Anaphothrips swezeyi Moulton (Lanai City)
Hercothrips fasciatus (Pergande) (west coast of the island)
Frankliniella minuta (Moulton) (mountains)
Frankliniella sulphurea Schmutz (Lanai City)
Isoneurothrips antennatus Moulton (mountains)
Plesiothrips panicus (Moulton) (Lanai City)
Hoplothrips flavitibia Moulton (Maunalei gulch, and in the mountains)

Molokai

Hoplothrips flavitibia Moulton (Halawa Valley and Mapulehu)

Maui

Organothrips bianchii Hood (Waihee)
Docidothrips trespinus (Moulton) (Huelo)
Taeniothrips cyperaceae Bianchi (Kihei)
Karnyothrips melaleuca (Bagnall) (Pauwela)
Haplothrips fusca Moulton (Kihei)
Haplothrips sesuvii Priesner (Kihei)

Insects on *Opuntia*—Mr. Krauss exhibited a collection of insects, identified by Mr. Pemberton, collected January 22 at Keawanui, Molokai on a cactus, *Opuntia megacantha,* attacked by *Fusarium* disease:

Dactylosternum dispar Sharp (a new island record)
Numerous larvae of a syrphid, probably *Volucella pusilla* (Macquart), many of which were flying about
Copris incertus prociduus Say (one specimen)
Belonuchus ophippiatus (Say) (two specimens) (a new island record for this staphylinid)

MARCH 8, 1948

The 507th meeting was held at the H.S.P.A. Experiment Station on Monday, March 8, at 2:00 p.m., with Vice-President Balock in the chair.

Members present: Balock, Beller, Bianchi, Joyce, Keck, Krauss, Lewis, Mainland, Nishida, Pemberton, Ritchie, Rosa, Sakimura, Stout, Swezey, Tuthill, Van Zwaluwenburg, Weber and Zimmerman.

Visitor: John H. Fales.

Miss Constance Inada was elected to active membership, and Miss Mabel Chong was nominated for membership.

NOTES AND EXHIBITIONS

Latrodectus geometricus Koch—Mr. Pemberton said that he had recently observed a female of the false black widow spider feeding on a freshly killed female of the house spider, *Heteropoda regia* (Fabr.). This was at the edge of the *Latrodectus* nest which contained two egg-sacs filled with unhatched eggs. The *Heteropoda* was carrying an egg sac in which were a number of newly hatched young. A few feet away from this nest Mr. Bianchi observed another *geometricus* nest in which was a well-grown, freshly killed scorpion, *Isometrus maculatus* DeGeer.

Dacus dorsalis Hendel—Mr. Weber gave the following list of previously unrecorded hosts of the oriental fruitfly, reared from field-collected fruits by Miss Chong, and all from Oahu with the exception of *Dovyalis* which was from Maui:

Averrhoa carambola	Carambola
Bumelia rotundifolia	
Capsicum frutescens abbreviatum	
Chrysophyllum oliviforme	Damson plum
Citrus limon	Lemon
Citrus reticulata	Tangerine
Dovyalis hebecarpa	Ceylon gooseberry
Euphoria longan	Longan
Fortunella japonica var. hazara	Chinese orange
Garcinia xanthochymus	
Mammea americana	Mammee apple
Mimusops elengi	Elengi
Passiflora laurifolia	Lemiwai

Eutreta xanthochaeta Aldrich—Mr. Weber reported that in several lots of field-collected galls on *Lantana* held for emergence of this tephritid fly, puparia from which adults later emerged were

found at the bottom of the jars. No previous records are known of *Eutreta* larvae leaving the galls to pupate; it is thought probable that these maggots left the galls because of the drying out of the material.

A new trichopteron—Miss Inada reported that on September 29, 1947 Dr. H. A. Banner collected trichopterous larvae in the lily pond at Moanalua Gardens, while collecting plankton material. According to Mr. Zimmerman the larvae appear to be distinct from those collected by him in the same locality in October 1940 (Proc. Haw. Ent. Soc., **11**: 350, 1943) which later proved to be *Oxyethira maya* Denning.

Chrysobothris sp.—Mr. Zimmerman exhibited the third example of this immigrant buprestid beetle to be taken in the Territory. It was collected by T. Tanaka, November 22, 1947, at Moiliili, Honolulu. The earlier specimens were collected in the Makiki district of the city in June 1946, and in nearly the same locality in May 1947.

Exitianus sp.—Mr. Zimmerman reported that this new immigrant cicadellid leafhopper was first taken in the H.S.P.A. light trap at Iroquois Point, Oahu, October 30, 1947. It was studied by Dr. P. W. Oman of the U. S. National Museum, who states that it appears to belong in the North American *E. exitiosus* (Uhler)—*obscurinervis* (Stål) complex. Essig, in his "Insects of Western North America" calls *exitiosus* "the destructive leafhopper," and notes that "It is widely distributed in North America . . . It may often be present in swarms and is destructive to grasses and grains."

Two new tenebrionids—Mr. Zimmerman exhibited two tenebrionid beetles new to the Territory, both taken in the H.S.P.A. light trap at Iroquois Point, Oahu, in November, 1947. One is *Doliema plana* (Fabr.), widespread in the Americas; the other belongs to "a genus near *Palorus*," according to Dr. E. A. Chapin of the U. S. National Museum, who identified both insects.

Monotoma sp.—This beetle (see p. 341), first taken in a light trap at Iroquois Point, Oahu, August 4, 1947 (Proc. Haw. Ent. Soc., **13**: 213, 1948) has been identified as belonging to this genus of the family Monotomidae, by W. S. Fisher. Over 250 species are known in this genus, and Mr. Fisher does not give it a specific name.

A new hydrophilid—Mr. Zimmerman reported that a hydrophilid beetle of a genus new to Hawaii, was collected from a freshwater pond in Nuuanu, Honolulu, by a student, Takuo Kono, February 23, 1948 (see p. 341). The larvae were seen feeding on mosquito larvae.

Coconut pests on Palmyra—Mr. Krauss exhibited adults of a small moth, *Agonoxena argaula* Meyrick (determined by Dr. Swezey) (family Agonoxenidae), the larvae of which he found abundant on coconut foliage on Palmyra Island in February 1948. The larvae feed on the under surface of the leaves and cause elongate brown blotches. Mr. Krauss also noted damage to coconuts by rats on the island, and that coconut crabs (*Birgus latro* Herbst) were fairly common.

Eurytoma orchidearum (Westwood)—Mr. Krauss reported that

larvae of this "Cattleya fly," a eurytomid wasp, were causing considerable damage to leafbuds of *Cattleya* orchids in greenhouses at Aiea Heights, Oahu, in February. This species has been reported by growers in Hawaii occasionally over a period of years.

Pteropus mariannus Desmarest—Mr. Krauss exhibited a dead fruit bat, or "flying fox," of this species, brought alive to Hawaii from Guam recently. It was confiscated by the Board of Agriculture & Forestry in accordance with Territorial law. This bat feeds on a variety of fruits, and is itself sometimes eaten by natives of Guam. The bat was identified by Mr. Bryan.

APRIL 12, 1948

The 508th meeting was held at the H.S.P.A. Experiment Station on Monday, April 12, at 2:00 p.m., with President Fullaway in the chair.

Members present: Alicata, Bianchi, Bonnet, Fullaway, Joyce, Krauss, Mainland, Nishida, Pemberton, Rosa, Swezey, Tanada, Tuthill, Van Zwaluwenburg and Weber.

Visitor: Henry S. Dybas.

Miss Mabel Chong was elected a member of the Society.

PAPER

Mr. Tanada presented a paper by Curtis W. Sabrosky entitled: "The Muscid Genus Ophyra in the Pacific Region (Diptera)."

NOTES AND EXHIBITIONS

Anacamptodes fragilaria (Grossbeck) — Mr. Bianchi reported finding the caterpillars of this geometrid moth feeding on kiawe (*Prosopis chilensis*) near Kawaihae, Hawaii, March 28; this is a new island record. The caterpillars were fairly abundant there, but at Mahukona, a few miles away, an hour's search revealed only a single dead caterpillar, none alive.

Achaea janata (Linn.)—Mr. Bianchi reported that this agrotid moth remains much more common on Hawaii than on Oahu. Near Pahala and Naalehu particularly, fluctuations in *Achaea* populations are reflected by periodic increase and decrease of injury on *Ricinus*, a favored hostplant. On Oahu no feeding on *Ricinus* has been observed for many months, nor has the insect been common on cultivated hosts as was so often the case during the first year of its establishment on Oahu.

Latrodectus spp.—Mr. Bianchi reported that on March 26 at South Point, Hawaii, he found almost as many egg cocoons and adults of *L. geometricus* Koch as were present when he last visited the area in 1946. *L. mactans* (Fabr.), on the other hand, has almost disappeared, for a morning's search revealed but one egg case of this species. Of the two parasites previously liberated at South Point, *Baeus californicus* Pierce was found not at all, but *Eurytoma* sp. was extremely abundant, flying about and present in at least 80 per cent of all the egg masses examined.

Macrosiphum luteum (Buckton)—It was reported for Mr. Look that he found a heavy infestation of this orchid aphid attacking several species of *Dendrobium* and *Phalaenopsis* at Hilo, Hawaii, in March 1948. The aphid was identified by E. O. Essig. The greatest population was on foliage, flowers and terminal shoots of *D. phalaenopsis* growing in a lath house; only flowers and buds of *Phalaenopsis* were infested. Mr. Krauss added that this same aphid was found by Stephen Au on orchids on Kauai in March (identified by Mr. Weber by comparison with material named by Mr. Essig). In January of this year the species was found infesting *Epidendrum* plants from California in a quarantine house in Honolulu, but this infestation was believed to have been eradicated. However, subsequently Mr. Pemberton reported that *M. luteum* was found by Dr. H. L. Lyon on April 14, infesting flower spikes of *Dendrobium* sp. growing outdoors at Foster Gardens, Honolulu. Hence this new immigrant aphid has been discovered almost simultaneously on Hawaii, Oahu and Kauai.

Dacus dorsalis Hendel—Mr. Weber reported the following new host records for this tephritid fly, all supplied from field-collected fruits by the local Division of Foreign Plant Quarantine, U. S. Bureau of Entomology & Plant Quarantine:

Annona reticulata	Bullock's heart
Artabotrys uncinatus	Ylang-ylang
Coffea liberica	Liberian coffee
Flacourtia indica	Governor's plum
Gossypium barbadense	Cotton
Inga laurina	
Manilkara emarginata	
Murraya exotica	Mock orange
Noronhia emarginata	Madagascar plum
Passiflora subpeltata	
Pimenta dioica (officinalis)	Allspice
Pimenta racemosa (acris)	Bay
Pithecellobium (Pithecolobium) dulce	Opiuma
Polyalthia longifolia	
Prunus domestica	Plum
Yucca aloifolia	

All the plant identifications, except *Yucca,* are by Miss Marie Neal of the Bishop Museum. In addition to the above named field-collected hosts, *D. dorsalis* was bred in cage tests on apple (*Pyrus malus*) and on bitter melon (*Momordica charantia*).

Mr. Weber also reported specific names for some hosts of *dorsalis* reported to genus only by Mr. Look last year:

Ripe bananas (Proc. Haw. Ent. Soc., 13: 11); this record is of *Musa nana* (*cavendishii*)

Oranges (l.c.: 13); *Citrus sinensis*

Prunus sp. (l.c.: 20); *Prunus salicina* × *P. cerasifera* (Methley plum)

Passiflora sp. (l.c.: 20); *P. edulis* var. *flavicarpa*

Mr. Van Zwaluwenburg reported rearing *D. dorsalis* from field-collected fruits of the Chinese banyan (*Ficus retusa*), the Port

Jackson fig (*Ficus rubiginosa*), and the Moreton Bay fig (*Ficus macrophylla*). The fruits of *F. retusa* were collected for him by Masaru Tanaka at Kailua, Oahu, March 1; from about 90 fruits 18 adult *dorsalis* were reared. On March 11 Mr. Rosa and he collected 13 fruits of *F. rubiginosa* at Ewa Plantation Co., Oahu, from which 18 flies (9 males and 9 females) issued between March 29 and April 1. Mr. Rosa and he collected 87 fruits of *F. macrophylla* in Makiki Park, Honolulu, on March 16; 97 flies (54 males and 43 females) emerged from this material between April 1 and April 7. The flies from *retusa* and *rubiginosa* were generally smaller than those from *macrophylla*.

These *Ficus* host fruits are the only three species of the genus for which the specific pollinating wasps have been introduced and become widely established in Hawaii. The Mission Black variety of commercial fig (*Ficus carica*) is usually not pollinated here, but produces edible fruit which is readily attacked by *dorsalis*. Efforts to rear this fly from the sterile fruits of *Ficus heterophylla* have been unsuccessful even though attempted oviposition in them by female *dorsalis* has been observed in the field.

Stictoptera subobliqua (Walker)—Mr. Weber exhibited larvae and adults of this agrotid moth, here recorded for the first time from the Hawaiian Islands. It was first taken on *Mammea americana* at the Honolulu Academy of Arts on March 18, 1948, having been called to Mr. Weber's attention by Mr. Duncan of the Academy staff. Larvae have since been found feeding on foliage of *Calophyllum inophyllum* and *Garcinia cambogia*. Typical damage has also been seen on *Garcinia xanthochymus*. According to Swezey (Insects of Guam **II**: 169, 1946) this moth is known from Ceylon, Sikhim, North Assam, Singapore, British New Guinea and Guam. In Guam it feeds on *Ochrocarpus obovalis;* all its hostplants known so far belong to the family Guttiferae.

Aphidius sp.—Mr. Weber exhibited a specimen of this aphid parasite new to the Islands. It was found in a tube of galls of pamakani (*Eupatorium adenophorum*) collected on Tantalus, Oahu, February 24, 1948, which were being held for emergence of parasites of *Procecidochares utilis* Stone, the pamakani tephritid.

Rhopalosiphoninus latysiphon (Davidson)—Mr. Krauss exhibited a single alate of this aphid, called the myrtle aphid, collected November 14, 1947 on an unknown hostplant at Olinda, Maui; identification was by E. O. Essig. The species is known from Europe and the San Francisco Bay region of California; it has been recorded from chrysanthemum, cowslip, *Vinca,* Shasta daisy, morning glory and potato. Mr. Pemberton reported that Mr. Bianchi had also collected this aphid at Pohakuloa, Hawaii, while sweeping grass, March 28, 1948. This aphid is new to the Territory.

New drosophilids—Dr. Mainland reported the following exotic species of drosophilid flies not previously known from Hawaii,

taken March 18, 1948, in a banana trap on the University of Hawaii campus, Honolulu:

Drosophila repleta Wollaston
Drosophila immigrans Sturtevant
Drosophila sp.

Earlier records of both *repleta* and *immigrans* from the Hawaiian Islands were based on misidentifications.

Simodactylus marianorum Van Zwaluwenburg—Mr. Van Zwaluwenburg reported that this elaterid beetle, recently described from Guam, Rota and Tinian (Proc. Haw. Ent. Soc., 13: 270, 1948) was collected on Saipan in December by K. L. Maehler.

Encarsia formosa Gahan—Dr. Swezey exhibited specimens of this aphelinid which were reared from *Trialeurodes vaporariorum* (Westwood) on *Sonchus oleraceus*. He found parasitized aleurodids by the roadside along Punahou School grounds, March 19, 1948, at the Experiment Station, H.S.P.A. grounds, April 1 and 12, and on Hunnewell St., in Manoa, April 4. Mr. Fullaway recognized the species as one that he introduced in 1942 from the parasite laboratory at Ontario, Canada. It was reared abundantly at that time and liberated on beans heavily infested by *Trialeurodes* at Waianae, Oahu. It had not previously been recovered.

Bemisia giffardi (Kotinsky)—Dr. Swezey reported a heavy infestation by this aleurodid on *Clausena lansium* in Foster Gardens, Honolulu, April 3, 1948. Apparently this is a new hostplant for this species which commonly infests various kinds of *Citrus*. Both plants are in the family Rutaceae. The tree was black with sooty mold, which had flourished on abundant honeydew excreted by the aleurodids.

Insects from dead breadfruit wood—Dr. Swezey reported the following insects which issued from a dead branch of breadfruit tree in his garden, January 7 to March 29:

100 *Ericryphalus henshawi* Hopkins
453 *Ericryphalus* sp.
2 *Xyleborus fornicatus* Eichhoff
3 *Oxydema fusiforme* Wollaston
1 *Araecerus fasciculatus* (DeGeer)
28 *Oopsis nutator* (Fabr.)
2 *Sybra alternans* Wiedemann
1 *Pterolophia camura* Newman
1 *Lagocheirus obsoletus* Thomson
4 *Opogona purpuriella* Swezey
3 Spalangidae

Toxoptera aurantii (Boyer de Fonscolombe)—Mr. Fullaway reported finding this aphid on *Calophyllum inophyllum*, a new host record, at Punaluu, Oahu, March 31.

MAY 10, 1948

The 509th meeting was held at the H.S.P.A. Experiment Station on Monday, May 10, at 2:00 p.m., with President Fullaway in the chair.

Members present: Bianchi, Bonnet, Chong, Fullaway, Holdaway, Joyce, Kartman, Keck, Mainland, Nishida, Pemberton, Rosa, Swezey, Tanada, Tuthill, Van Zwaluwenburg, Weber and Zimmerman.

Visitor: Norman E. Flitters.

Mr. Flitters was nominated for membership in the Society.

PAPERS

Dr. Swezey submitted his paper entitled: "Synonymy of Hypocryphalus mangiferae (Stebbing) and its Occurrence in Hawaii (Coleoptera: Scolytidae)." Mr. Zimmerman presented Dr. Usinger's paper: "War-time Dispersal of Pacific Island Nysius (Hemiptera: Lygaeidae)." Mr. Bianchi presented a paper entitled: "Recent Changes in the Parasite Complex of Armyworms."

NOTES AND EXHIBITIONS

Eumenes pyriformis philippinensis Bequaert—Dr. Swezey exhibited a photograph of a mud nest of this eumenid wasp which Dr. Lyon had found on a *Dendrobium* in his orchid house. He had watched the wasp build one cell after another and store caterpillars in them. Dr. Swezey opened the three central cells to determine the species of caterpillars; they were all the geometrid, *Anacamptodes fragilaria* (Grossbeck), and there were six to eight per cell. One cell contained a nearly full-grown larva. It was fed six caterpillars in addition to those already in its cell, and it had accordingly grown to a larger size than usual. Later note: The wasp failed to issue from the cocoon and on later examination was found to have matured and died within the cocoon.

Stictoptera subobliqua (Walker)—Dr. Swezey reported finding three eggs of this most recent immigrant agrotid moth on a leaf of *Calophyllum inophyllum* at the University on April 4. They hatched April 7, and grew rapidly; two pupated on April 22, and reached the adult stage on May 2 and May 4. Thus the larval stage was 15 days, and the pupal stage 10 to 12 days.

Chelonus texanus Cresson—Mr. Bianchi reported finding adults of this braconid parasite of armyworms at Honokaa, Hawaii, a new island record. He discussed the present status of armyworms in sugarcane fields on Hawaii, and said that the parasites dominant there at present are the braconids *Meteorus laphygmae* Viereck and *Apanteles marginiventris* Cresson, and the tachinid *Eucelatoria armigera* (Coquillett).

Brachymeria fonscolombei (Dufour)—Mr. Weber exhibited specimens of this new immigrant chalcid (identified by A. B. Gahan), parasitic in blowfly larvae. It was first captured on a store

window at Waipahu, Oahu, August 1, 1947, and later was taken at Kaneohe, Oahu. It is known from central Europe, Russia, Java, Haiti, Mexico and the southern United States as far north as Illinois. Among its recorded hosts the following occur in Hawaii: *Phormia regina* (Meigen), *Phaenicia* (*Lucilia*) *sericata* (Meigen), *Sarcophaga haemorrhoidalis* (Fallen) and *Synthesiomyia nudiseta* (van der Wulp).

New hosts of *Dacus dorsalis* Hendel—The following new host records for this tephritid fly are all from field-collected fruits. (1) Mr. Weber reported for Dr. Ritchie that the local office of the Division of Foreign Plant Quarantines had reared this fly from *Zizyphus mauritiana* on Oahu. (2) Mr. Van Zwaluwenburg reported that Mr. Rosa and he had reared adults from fruits of *Ochrosia elliptica* collected April 15 at the Foster Gardens, Honolulu. (3) Dr. Holdaway and Mr. Tanada recorded breeding *D. dorsalis* from fallen macadamia nuts (*Macadamia ternifolia*) collected by C. Lyman at Pahala, Hawaii, April 14. These nuts had fallen prematurely; some of the larger nuts (all were immature) had split open and had the kernel exposed. From three cracked nuts three adult *dorsalis* emerged. Whether the fly was responsible for the dropping and cracking of the immature nuts, or whether the cause was physiological, is not known. (4) Mr. Flitters reported that Mr. Balock had recently reared 29 *D. dorsalis* from four fruits of *Calophyllum inophyllum*.

Graphomya maculata (Scopoli)—Mr. Joyce exhibited a male specimen of this muscid fly (determined by C. W. Sabrosky), taken on a screen, March 2, 1948, at the quarantine station, Ft. Armstrong, Honolulu. This is apparently the first record of its capture in Hawaii. A widespread species, it has been reported from Europe, Alaska, Canada, United States, South America and Australia. The specimen is a pale one, the species usually being darker in color. Further intensive collecting in the Ft. Armstrong area has failed to reveal any more specimens. The females are known to lay only a few eggs, so the species is seldom found in abundance. The proximity of the place of capture to the harbor area suggests that the species was recently introduced through commerce.

G. maculata may readily be distinguished from other Muscidae in Hawaii by the following combination of characters: Antennae separated at base by carina; sternopleura with two bristles behind, none in front; propleura bare in middle; pteropleura bare; prosternum bare; squama dusky, lower lobe large, reaching base of scutellum; body gray, partly rufous with well-defined black lines on thorax and black spots on abdomen.

Incidence of *Aedes* in Honolulu—Dr. Bonnet reported on a survey, completed April 20, of the distribution of *Aedes aegypti* (L.) and *A. albopictus* (Skuse) in the city of Honolulu. On 42,764 premises inspected, a total of 1,534 containers were found breeding *Aedes* mosquitoes. Of this number 1,523 were *A. albopictus* and only 11 were *A. aegypti*. All of the *A. aegypti* were found on the

makai (seaward) side of a line drawn along Beretania St. The following table presents data of previous surveys, although it is not known if the figures are all comparable on the basis of sampling methods:

Year	Per cent *A. albopictus*	Per cent *A. aegypti*
1911	50	50
1912	80	20
1913	33	67
1914	91.6	8.4
1915	91.6	8.4
1926	99.2	0.8
1943	85	15
1944	93.5	6.5
1948	99.3	0.7

Mr. Kartman remarked that in his experience during the recent war, in both East and West Africa, *Aedes aegypti* was never found as adult or larva in dwellings, but that the adults were invariably found away from habitations, and their larvae in tree-holes and in water-holding plants. These observations, the reverse of those for this species in the Americas, were corroborated elsewhere in Africa by other groups studying *A. aegypti*.

JUNE 14, 1948

The 510th meeting was held at the H.S.P.A. Experiment Station on Monday, June 14, at 2:00 p.m., with President Fullaway in the chair.

Members present: Beller, Bianchi, Bryan, Carter, Fullaway, Holdaway, Inada, Joyce, Keck, Mainland, Pemberton, Rosa, Schmidt, Tuthill, Van Zwaluwenburg, Weber and Zimmerman.

Visitor: Lew E. Wallace.

Norman E. Flitters was elected to membership, and the name of Lew E. Wallace was proposed for membership.

PAPER

Mr. Zimmerman presented a paper by H. F. Strohecker entitled: "The Genus Spathomeles Gerstaecker, with the Description of a New Species from Borneo (Coleoptera: Endomychidae)."

NOTES AND EXHIBITIONS

Insect swarms in southerly weather—Dr. Carter reported that Iichi Yanagihara observed flights of great numbers of a small, unidentified staphylinid beetle on April 2 and April 8, and a flight of some 50 oedemerids, *Ananca bicolor* (Fairmaire), all in Honolulu. All these observations were made during "kona" weather.

Oechalia pacifica (Stål)—Dr. Tuthill reported the finding of this pentatomid bug in considerable numbers on Koko Head, Oahu,

May 16. The bugs were on *Crotalaria,* where they were apparently preying on lycaenid larvae. Mr. Van Zwaluwenburg reported that J. D. Bond had recently found nymphs of this bug in Manoa Valley, feeding on the larvae of the chrysomelid, *Lema trilineata californica* Schaeffer, on *Datura.*

A new slug—Dr. Tuthill exhibited specimens of what appears to be a new slug. They are about as large as the common black slug (*Veronicella*) and were found in trash about the base of a dead papaya tree on the University campus. Later this slug was identified by Dr. A. R. Mead as *Limax flavus* (L.).

Aphycus terryi Fullaway—Mr. Pemberton remarked that this encyrtid parasite of the gray mealybug, *Pseudococcus boninsis* (Kuwana), which was introduced into Louisiana from Hawaii in 1932 by Dr. Swezey, had subsequently been reported to be well established there. However, taxonomic studies by A. B. Gahan (Proc. U. S. Nat. Mus. **96**, no. 3200: 321-324, 1946) have shown that field-collected material from Louisiana, supposed to be *A. terryi,* proved without exception to be a new species, described by him as *Pseudaphycus mundus.* All evidence indicates that *A. terryi* is not established in Louisiana.

Calosoma blaptoides Putzeys subsp. *tehuacanum* (Lapouge)—Mr. Pemberton stated that he had recently had opportunity to compare critically, named specimens of *Calosoma semilaeve* LeConte, with specimens of *Calosoma* established at Waikii, Hawaii (Proc. Haw. Ent. Soc. **13**: 210, 1948), and that they are different. Specimens of the local *Calosoma* were sent to Dr. E. C. Van Dyke who replied on May 23, that our species is *blaptoides tehuacanum.* This proves to be the species introduced into Hawaii from Cuernavaca, Mexico, by H. T. Osborn in September 1923. At that time 30 adult beetles were liberated at Waikii, Hawaii; the species was not seen again until May 1947 when Dr. Swezey and W. C. Look recovered specimens in the general vicinity of the original liberation. When this recovery was reported last year it was assumed that the beetle was *C. semilaeve* because a large number of that species imported from Ventura County, California, in 1923 were also liberated at Waikii. The Mexican introduction was apparently overlooked.

Monotoma near *picipes* Herbst—Mr. Pemberton reported that this beetle, previously taken only in a light trap on Oahu, was taken in numbers similarly by Henry Alexander at Lahaina, Maui, June 1, 1948. This is a new island record.

Dacus dorsalis Hendel—Dr. Carter discussed the present status of this fruitfly in regard to pineapples, and concluded that this fruit is a definitely unfavorable host for the fly, in which it can only rarely reach maturity. Mr. Pemberton remarked that from six mango fruits collected May 15, and believed by the grower to be free of *Dacus,* a total of 936 *D. dorsalis* adults were reared. Mr. Weber reported rearing a single specimen of *D. dorsalis* from a small, immature coconut. The larva was found under the cap,

where the tissue at the top of the nut had begun to decay. It is not known if the decay was a predisposing factor to oviposition.

Dr. Mainland reported that in the female *D. dorsalis* dissection has revealed that the hind-gut and the posterior vagina are united into a common duct, a cloaca, just anterior to the last plate of the ovipositor. At the time of defecation the ovipositor is usually fully extended. Since the posterior genital tract and the posterior gut are united, it appears probable that the surface of all eggs may be contaminated by microorganisms present in the hind-gut at the time of oviposition.

Syritta orientalis Macquart—Mr. Weber exhibited a specimen of this syrphid fly, new to the Territory. It was first taken at Punaluu, Oahu, October 7, 1946, and has since been taken at Hickam Field and in Honolulu. The species is known from Java and Singapore; identification was by C. T. Greene.

Pison insulare Smith—Mr. Weber exhibited a series of this new sphecid wasp, first captured on the Kawaiiki trail, Oahu, November 2, 1947 (Proc. Haw. Ent. Soc., **13**: 222, 1948; as *Pison* sp.). The species was identified by K. V. Krombein; it is known from the New Hebrides.

A new corizid bug—Mr. Bianchi exhibited a series of a bug new to the Territory. It was found by Mr. Bianchi near a pineapple field at Poamoho, Oahu, May 26, 1948. A large number of adults and nymphs were present on ground with a thick weed cover in an area about 10 by 40 feet. The nymphs of all stages greatly resemble ants, both in movement and appearance. It feeds on a variety of legumes, and drops its eggs loosely instead of attaching them to the host plant. Later this insect was identified by Dr. P. W. Oman as *Coriscus pilosulus* (Herrick-Schaeffer), which occurs in the United States but is of no economic importance there.

Caenis sp.—Mr. Bianchi reported this ephemerid, known here only since 1944, to be extremely abundant at lights at Kailua, Oahu, June 11.

Ceroplastes rubens Maskell—Dr. Carter exhibited a mango leaf heavily infested by this wax scale. The tree had been given heavy applications of DDT about a year ago in an effort to combat *Dacus dorsalis*. The scale infestation on this particular tree is in striking contrast to untreated trees nearby which are relatively free from the scale.

A new gall midge—For Mr. Look it was reported that a heavy infestation of a cecidomyiid gall midge new to these islands, was found by him damaging leaves and stems of chrysanthemum grown under glass at Wainaku, Hilo, Hawaii, on May 14, 1948. Subsequently Dr. H. F. Barnes of Rothamsted, England, identified it as the chrysanthemum midge, *Diarthronomyia chrysanthemi* Ahlberg (Ent. Tidskrift, **60**: 274, 278, 1939; new name for *D. hypogaea* Felt, not Loew). To paraphrase Dr. Barnes' remarks: This is a well known pest in the United States, and sporadic outbreaks have

occurred in European countries, which have usually been traced back to importations of chrysanthemum cuttings from America. It is now well established in Europe. It was formerly known as *D. hypogaea* (F. Loew), a species described from wild chrysanthemum root galls in Europe. It is now generally accepted that the midge on cultivated chrysanthemums is distinct from *hypogaea*. Apparently the American species was misidentified. Dr. Barnes suggests nicotine dipping of cuttings, and routine sprays with nicotine.

Hercinothrips femoralis (Reuter)—Mr. Fullaway reported a heavy infestation by this thrips on *Crinum* lilies in Honolulu, June 7. This is a new host record.

JULY 12, 1948

The 511th meeting was held at the H.S.P.A. Experiment Station on Monday, July 12, at 2:00 p.m., with President Fullaway in the chair.

Members present: Bianchi, Bonnet, Bryan, Courtney, Flitters, Fullaway, Inada, Joyce, Kartman, Keck, Mainland, Nishida, Rosa, Schmidt, Stout, Tanada, Tuthill, Van Zwaluwenburg and Weber.

Lew E. Wallace was elected to membership in the Society.

PAPER

Mr. Bianchi presented a paper: "New Thrips Records and Species from the Marianas."

NOTES AND EXHIBITIONS

A new muscid fly—Mr. Joyce reported that six specimens of *Muscina stabulans* (Fallen) were taken in a rat-baited trap at Ft. Armstrong, Honolulu, June 13, 1948. This appears to be a new record for the Islands, although specimens have been recovered from planes arriving in Honolulu in past years. The adults of *M. stabulans* are very similar to the common housefly in appearance, but may be readily distinguished by the wing venation. The fourth longitudinal vein is bent feebly upward, not sharply bent as in *Musca domestica* L. *M. stabulans* occurs in houses as well as in stables, etc., and is sometimes called the non-biting stable fly. The larvae normally breed in manure and decaying matter, and have been reared from and captured on human excreta and cadavers. The female frequently oviposits on food, and the larvae have been involved in cases of intestinal myiasis in man. *M. stabulans* is almost cosmopolitan, being known from all the continents as well as from some of the Pacific islands.

Linognathus setosus (Olfers)—Mr. Joyce exhibited a specimen of this sucking louse of dog, found on a stray dog at Ft. Armstrong, Honolulu, May 5, 1948. Apparently the species has not previously been reported from Hawaii, although it is possible that

it has been here for some time. It is occasionally abundant on poorly kept dogs in every part of the world.

Dacus dorsalis Hendel—Dr. Schmidt commented on the high mortality of maggots of this fruitfly observed in unbroken mangoes. Mr. Fullaway suggested that some of it may have been due to sun heat, and others suggested the possible killing effect of fermentation.

Agonoxena argaula Meyrick—Mr. Van Zwaluwenburg exhibited coconut leaves damaged by an insect new to the Territory, an agonoxenid moth first found at Kahala, Honolulu, by Mr. Pemberton and himself, June 28, 1948. Infestation is heavy at Kahala and at Kaalawai, where the insect may have been present for many months. Light infestations were later found at Ft. Ruger and in Manoa Valley. Feeding is confined to the epidermis on the underside of the leaves. The feeding scar of the young larva is long and narrow, spreading into wide, irregular blotches as the caterpillar grows. Feeding areas turn brown and are conspicuous. The caterpillar is yellowish green and feeds beneath a web; it does not tie up the leaf as *Omiodes* does. Pupation takes place beneath a close, elongate, white web on either the upper or lower leaf surface. The egg is not known. From Kahala material a small specimen of *Zaleptopygus* (*Cremastus*) *flavo-orbitalis* (Cameron) emerged, and later investigation indicates that parasitism of *Agonoxena* by this ichneumonid is considerable.

Reared specimens agree well with the description of *A. argaula* (Exotic Microlep., 2: 472, 1921). The species was described from Fiji, and is known also from Samoa, the Ellice Islands and Palmyra. A related species, *A. pyrogramma* Meyrick, occurs in New Guinea, New Britain, the Solomons and Guam. Both species feed on coconut leaves. At Kahala typical *argaula* feeding was also seen on fan palm (*Pritchardia*).

Polydesma umbricola Boisduval—Mr. Van Zwaluwenburg reported a new hostplant for this agrotid moth. With Chester Wismer and Mr. Rosa he recently observed feeding by its larvae on pink shower (*Cassia grandis*) in Honolulu. Previously it was known only on *Albizzia lebbek, Pithecolobium dulce* and monkeypod.

Pseudoparlatoria parlatorioides (Comstock)—Mr. Fullaway exhibited specimens of this diaspine scale taken on *Cypripedium* orchids in Honolulu in June, 1948. This is a new insect for the Islands; the identification was by Mr. Fullaway.

AUGUST 9, 1948

The 512th meeting was held at the H.S.P.A. Experiment Station on Monday, August 9, at 2:00 p.m., with President Fullaway in the chair.

Members present: Balock, Beller, Bryan, Carter, Fullaway, Holdaway, Inada, Joyce, Keck, Mainland, Pemberton, Rosa, Stout,

Tanada, Tuthill, Van Zwaluwenburg, Wallace, Weber, and Zimmerman.

Visitors: Mrs. Lilla Armstrong, Miss Betty Lou Pelot, Dr. A. C. Baker and Dr. C. L. Marlatt.

Miss Pelot was nominated for membership in the Society.

Dr. Marlatt gave interesting reminiscences of his earlier visits to Hawaii. Mr. Beller presented the Society with a copy of his "Summary of the Insects and Flora of Guam," and Mr. Bryan distributed copies of his "Bibliography of Micronesian Entomology."

PAPER

Dr. Carter presented a paper by A. B. Gahan entitled: "Identity of the Anagyrus that Parasitizes the Pineapple Mealybug (Hymenoptera: Chalcidoidea: Encyrtidae)." The following paper was presented for K. V. Krombein: "Two new Wasps from Melanesia and Notes on a Third recently introduced into Hawaii (Hymenoptera: Sphecidae)."

NOTES AND EXHIBITIONS

Diorymerellus sp.—Dr. Carter exhibited an adult weevil of this genus which issued from a *Cattleya* plant in his orchid house on August 7. The orchid originated in Venezuela and the emergence of the weevil despite the treatment the plant had undergone in quarantine, emphasizes the difficulty of keeping out of the Territory certain types of insects from foreign countries.

Eumenes pyriformis philippinensis Bequaert—Mr. Van Zwaluwenburg presented rearing notes on this wasp. A broken nest containing an incomplete complement of immobilized caterpillars (only four *Anacamptodes* larvae were present instead of the usual six or eight) and a *Eumenes* egg, was received on the afternoon of July 8. By 8 a.m. the next day, the egg had hatched, and by 8 a.m. July 12, the *Eumenes* grub had entirely consumed the larvae present, and though apparently full grown, searched about for additional food for the next two days. Finally by July 15 it had spun a loose web of silk, had turned from white to yellow in color, and lost its mobility. Pupation occurred between July 17 and 19; the adult wasp issued July 30-31, but lay quiescent for two days before becoming active. The larval stage lasted between 8 and 11 days, and the pupal stage, 11-14 days. Because it had less than the usual number of caterpillars for food, the reared wasp was somewhat undersized.

In a general discussion of *Dacus dorsalis* Hendel, Dr. Baker stressed the value of field studies as an aid to segregating various species of fruitflies which superficially, and based on accepted taxonomic characters, appear to be the same but are actually distinct.

SEPTEMBER 13, 1948

The 513th meeting was held at the H.S.P.A. Experiment Station on Monday, September 13, at 2:00 p.m., with President Fullaway in the chair.

Members present: Bonnet, Bryan, Carter, Fullaway, Inada, Joyce, Keck, Mainland, Nishida, Pelot, Pemberton, Ritchie, Rosa, Stout, Tanada, Tuthill, Van Zwaluwenburg and Weber.

Visitors: Dr. Henry A. Bess, Ellery W. French and Dr. Stephen M. K. Hu.

Miss Betty Lou Pelot was elected to membership. Dr. Bess and Dr. Hu were nominated for membership and Ellery French for associate membership. Mr. Bunki Kumabe of Maui was nominated for corresponding membership.

NOTES AND EXHIBITIONS

Grapholitha molesta (Busck)—Dr. Tuthill reported finding a nearly mature larva of the oriental fruit moth in an apparently sound plum from California, purchased locally.

Dacus dorsalis Hendel—Mr. Weber reported rearing this tephritid fly from grapefruit obtained on August 11; the infested fruits were from a store in Kapahulu, Honolulu, where they had been exposed for an unknown time. He also reported that *D. dorsalis* had earlier been reared from the star apple (*Chrysomphyllum cainito*) by Miss Chong, but that the record had until now been overlooked.

Mr. Tanada reported that Dr. Holdaway and he reared 33 *D. dorsalis* adults from four bell peppers (*Capsicum frutescens grossum*) collected at Pahoa, Hawaii (600 ft. elev.) by M. Ueda, July 13. From the peppers was also reared one specimen of *Opius fletcheri* Silvestri (det. C. E. Pemberton). Bell pepper is also a host of *Dacus cucurbitae* Coquillett, so it is not certain that the parasite was attacking *dorsalis* in this instance, even though no *cucurbitae* were obtained. However, it is of interest to note that the Board of Agriculture and Forestry has reared *fletcheri* from *D. dorsalis* in the laboratory.

Mr. Van Zwaluwenburg reported that Mr. Rosa and he had reared six *D. dorsalis* from 38 fruits of the introduced kou, *Cordia sebestena*.

Eumenes latreillei petiolaris Schulz—Mr. Weber reported that this wasp was seen by Stephen Au on August 19 in the Makaweli district of Kauai, where it is known to have been present since at least June of this year. This is a new island record.

Agonoxena argaula Meyrick—Mr. Van Zwaluwenburg reported further hosts of this recently discovered moth, most of them identified by Mr. Weber. Besides coconut and *Pritchardia* palms, larvae have been found feeding extensively on leaves of *Kentia* palm; bottle palm, *Hyophorbe amaricaulis;* and areca palm, *Chrysalidocarpus lutescens*.

Cerambycid in orchids—Mr. Weber spoke of damage done to pseudo-bulbs of certain orchids. (*Dendrobium* and *Cattleya*) by cerambycid larvae identified by the U. S. National Museum as belonging to the subfamily Lamiinae. A number of these larvae have been taken recently in local orchid houses. Later note: Reared

specimens subsequently proved to be the common immigrant, *Sybra alternans* Wiedemann.

Orosius argentatus (Evans)—Mr. Fullaway called attention to a paper (Journ. Counc. Sc. and Ind. Res., 16: 86-90, Canberra, 1943) in which a virus disease of tomatoes and certain ornamentals in Australia, called "big bud of tomato," is shown to be transmitted by this cicadellid. The species does not occur in Hawaii; *Nesaloha cantonis* Oman is a synonym.

Damage to *Albizzia*—Mr. Pemberton exhibited a branch of *Albizzia saponaria* which showed to an exaggerated degree bud swellings such as have commonly been attributed to feeding on the unopened buds of monkeypod by the agrotid moth, *Polydesma umbricola* Boisduval. However, Dr. Carter said that similar damage to monkeypod (*Samanea*) had been familiar to him long before the advent of *Polydesma* to the Territory, and that therefore the swelling of the buds could be caused by other factors in addition to the work of *Polydesma*. A buprestid larva was present in one of the semi-decayed buds, which on rearing to adult later proved to be *Agrilus extraneus* Fisher, an immigrant species known here as early as 1908, and described in 1933. It is known only from Oahu.

OCTOBER 11, 1948

The 514th meeting was held at the H.S.P.A. Experiment Station on Monday, October 11, at 2:00 p.m., with Vice-President Balock in the chair.

Members present: Alicata, Balock, Bess, Bonnet, Flitters, Hu, Inada, Joyce, Keck, Lewis, Look, Maehler, Mainland, Marlowe, Nishida, Pelot, Pemberton, Ritchie, Rosa, Ross, Stout, Swezey, Tanada, Tuthill, Van Zwaluwenburg and Zimmerman.

Visitors: Dr. D. W. Clancy, Dr. D. E. Hardy, F. G. Hinman and L. B. Loring.

Dr. H. A. Bess and Dr Stephen M. K. Hu were elected to membership, Ellery W. French to associate membership, and Bunki Kumabe to corresponding membership in the Society. The following were nominated for membership: Dr. Clancy, Dr. Hardy and Mr. Hinman.

PAPER

Mr. Van Zwaluwenburg presented: "Notes on Parasites of Agonoxena argaula Meyrick."

NOTES AND EXHIBITIONS

Vanduzea segmentata (Fowler)—Miss Inada exhibited specimens of a membracid new to the Territory, which she and T. Kono collected in Honolulu, August 17, 1948, on eggplant. Nymphs and adults were seen feeding at the stem ends, and a few were seen on the calyx of the fruit also. Most of them were attended by *Pheidole megacephala* (Fabr.). The membracid was identified by Miss Louise M. Russell of the U. S. National Museum; she states

that the recorded distribution of this insect is Arizona, Texas, Louisiana, Mexico and Central America. Recently, among student collections at the University, Dr. Tuthill found this same species collected April 20, 1948, Honolulu, without hostplant data.

Sarcophaga ruficornis (Fabr.)—Mr. Joyce reported this fly, new to the Islands, taken by him in Honolulu, July 16, 1947, and found also in the H.S.P.A. collection where 2 males and 1 female are present, collected in Honolulu, May 3, 1940, by O. H. Swezey. The species has a wide distribution, mainly oriental: Ceylon, Chagos Islands, India, Malay States, Formosa, Philippines, China (Hong Kong) and northeast Africa. It is said to cause occasionally a very severe form of dermal myiasis in India, and has also been reported in intestinal myiasis.

Dacus dorsalis Hendel—Mr. Nishida reported a new host fruit for this fly. From 24 ripe fruits of the latania palm (*Latania loddigessii*) picked up from the ground, 288 adult *D. dorsalis* emerged. Infestation apparently does not take place while fruits are still on the tree, for no flies were obtained from 12 ripe and 13 immature fruits picked from the tree.

Mr. Pemberton stated that Q. C. Chock of the Board of Agriculture and Forestry had reported to him that he had reared *Dirhinus giffardii* Silvestri, *Spalangia philippinensis* Fullaway, *Tetrastichus giffardii* Silvestri and *Pachycrepoideus dubius* Ashmead from puparia of *D. dorsalis* in the outdoor laboratory of the Board in Honolulu. These puparia were obtained from guavas collected on Oahu. The pupal parasites *Dirhinus* and *Spalangia* must have entered the laboratory from the adjacent grounds, whereas *Tetrastichus* and *Pachycrepoideus* could have parasitized the fly larvae in the field before the fruit was collected, or they could have entered the laboratory and parasitized the larvae after the fruit was brought in. All of these insects have been established in the Territory for many years and have formed part of the complex of Mediterranean fruitfly parasites. Mr. Chock also reported recently rearing good numbers of *Opius longicaudatus* (Ashmead) from *D. dorsalis* from guavas collected in Nuuanu Valley, Honolulu. This is the first recovery of this opiine, which was imported from the Malay Peninsula during the summer of 1948. *O. longicaudatus* was described from the Philippines as a *Biosteres* (Proc. U. S. Nat. Mus., 28: 970, 1905).

Dacus cucurbitae Coquillett—Mr. Nishida reported rearing 10 adults of the melon fly from 3 fruits of *Passiflora seemanni*. This is a new host record; the fruit was identified by W. B. Storey.

Aceria litchii (Keifer)—Mr. Nishida reported that, according to a recent letter from H. H. Keifer, the name of the litchi erinose mite is now *Aceria litchii*. Formerly it was referred to in the local literature as *Eriophyes chinensis* Trotter, and more recently as *Eriophyes litchii* Keifer.

Oryctes rhinoceros (L.)—Dr. Alicata said that losses from this insect are so severe and remedial measures so inadequate, that planters in Western Samoa are reported shifting from coconut to cacao culture.

NOVEMBER 9, 1948

The 515th meeting was held at the H.S.P.A. Experiment Station on Monday, November 9, at 2:00 p.m., with Vice-President Balock in the chair.

Members present: Balock, Bess, Bianchi, Bonnet, Clancy, French, Hardy, Hinman, Hu, Inada, Joyce, Look, Nishida, Pelot, Pemberton, Rosa, Schmidt, Swezey, Tuthill and Van Zwaluwenburg.

Visitor: C. W. Schwabe.

Dr. D. W. Clancy, Dr. D. Elmo Hardy and F. G. Hinman were elected to membership. C. W. Schwabe was nominated for associate membership.

PAPERS

Dr. Tuthill presented a paper by Calvin W. Schwabe entitled: "Observations on the Life History of Pycnoscelus surinamensis (Linn.), the intermediate Host of the Chicken Eyeworm in Hawaii"; K. V. Krombein's paper was presented: "The Aculeate Hymenoptera of Micronesia. I. Scoliidae, Mutillidae, Pompilidae and Sphecidae."

NOTES AND EXHIBITIONS

Phytomyza spicata Malloch—Mr. Pemberton reported finding this agromyzid fly mining leaves of Johnson grass at Wailuku, Maui, November 5. Mr. Van Zwaluwenburg added that he had found the same fly in *Setaria verticillata* at Mapulehu, Molokai, November 4. Both are new island records.

Leptomastix dactylopii Howard — Dr. Swezey exhibited both sexes of this encyrtid, reared from a light infestation of *Pseudococcus citri* (Risso) on poinsettia leaves in Honolulu. Sixteen of the parasites issued October 20-22, a single parasite per host mealybug. The first record of this species in Hawaii was by D. T. Fullaway in February 1945 (Proc. Haw. Ent. Soc. **12**: 464, 1946) of specimens reared from a mixed infestation of *Phenacoccus gossypii* Towns. & Ckll. and *Pseudococcus kraunhiae* (Kuwana) on soybean and eggplant. Mr. Fullaway considered it to be an accidental introduction from California. Harold Compere (Univ. Calif. Pub. in Ent., **7**, no. 4: 57, fig. 1) records it in California as having issued (a single pair) in December 1934, from *Pseudococcus citri* imported from Brazil. The progeny of this pair increased to more than 4 million within a year, and were distributed to the orchards of California. The species was described in 1885 (U. S. Bur. Ent., Bull. **5**: 23).

New host of melon fly—Dr. Hardy reported that *Dacus cucurbitae* Coquillett was recently reared from kai choy (*Brassica juncea*) from Hilo. This apparently is a new host record and establishes the fact that this fly will attack at least some of the cabbages. The Assistant County Agent at Hilo reported infestations on kai choy rather general in the Hilo area, and that the fly is causing severe damage in some fields.

Dacus dorsalis Hendel — Mr. Van Zwaluwenburg reported finding eggs and larvae of the oriental fruitfly in berries of the beach naupaka (*Scaevola frutescens sericea*) collected by Mr. Pemberton and himself at Kawela Bay, Oahu, October 17. Apparently this host is not a very favorable one for the fly, for later it was found that none of the maggots in this lot of material succeeded in forming puparia. However, a single adult *dorsalis* was bred from *Scaevola* berries collected later in the same area.

Sarcophaga ruficornis (Fabr.)—Mr. Joyce recorded the occurrence of this fly on Kauai, based on collections by F. G. Holdaway at Wailua ranch, December 11, 1940 (3 males and 3 females), and at Kapaa, December 21, 1940, from manure (1 female).

DECEMBER 13, 1948

The 516th meeting was held at the H.S.P.A. Experiment Station on Monday, December 13, at 2:00 p.m., with Vice-President Balock in the chair.

Members present: Balock, Bess, Bianchi, Bonnet, Bryan, French, Hardy, Hu, Inada, Joyce, Keck, Lewis, Look, Nishida, Pelot, Ritchie, Rosa, Schmidt, Schwabe, Stout, Suehiro, Swezey, Tuthill, Van Zwaluwenburg and Zimmerman.

Visitor: L. Schoening.

C. W. Schwabe was elected to associate membership.

It being the annual meeting, the following slate of officers to serve during the coming year, was presented:

President	J. W. Balock
Vice-President	L. D. Tuthill
Secretary-Treasurer	R. H. Van Zwaluwenburg
Additional members of Executive Committee	D. T. Fullaway C. R. Joyce

There were no further nominations, so the above nominees were elected.

In the absence of the President, Vice-President Balock read Mr. Fullaway's presidential address: "Dacus dorsalis Hendel, in Hawaii."

PAPERS

A paper by O. C. McBride and Y. Tanada was presented, entitled: "A Revised List of Host Plants of the Melon Fly in Hawaii." Mr. Zimmerman presented his paper: "A new Dynatopechus Weevil injuring Lima Beans in Hawaii (Coleoptera: Curculionidae)."

NOTES AND EXHIBITIONS

Opius persulcatus (Silvestri)—A note was presented for Mr. Pemberton in which it was reported that Q. C. Chock had reared this opiine parasite from puparia of *Dacus dorsalis* Hendel ob-

tained from field-collected fruit on Oahu during November 1948. This parasite was introduced from the Philippines and the Malay Peninsula during 1948. It is the second parasite on *D. dorsalis* to become established here, the first being *Opius longicaudatus* (Ashmead). *O. persulcatus* was described from India as *Biosteres* (Boll. Lab. Zool., Portici, **11**: 167, fig. 5, 1916).

Identifications of new immigrant insects—Mr. Zimmerman reported the identifications of some recent immigrant insects, received from the U. S. National Museum:

Fulvius brevicornis (Reuter), Heteroptera: Miridae; determined by R. I. Sailer (see *Fulvius* sp., Proc. Haw. Ent. Soc., **13**: 213, 1948).

The monotomid beetle believed to be a fungus feeder, reported earlier this year (see p. 323) is near *Monotoma picipes* Herbst, a widespread species, but L. L. Buchanan reports that our specimen sent for comparison is paler and somewhat broader than any specimens under this name in the National Museum collection.

Tropisternus lateralis var. *dorsalis* Brullé, is the hydrophilid beetle reported at the March meeting (see p. 323) ; it is known from western North America and from Central and South America. Mr. Buchanan identified the beetle.

Chrysobothris sp. This buprestid beetle, first taken in Hawaii in 1946 (Proc. Haw. Ent. Soc., **13**: 12, 1947) has been determined by W. S. Fisher as near *Chrysobothris tristis* Deyrolle, from the Austro-Malayan region.

Diaperis maculata Olivier; this is the red and black tenebrionid beetle first taken at Iroquois Point, Oahu, in 1947 (Proc. Haw. Ent. Soc., **13**: 212, 1948). It is a variable, widespread species, and was identified by Dr. R. E. Blackwelder.

Recent coccinellid introductions—Mr. Zimmerman reported that during the year the following African Coccinellidae were introduced into Hawaii by the H.S.P.A. Experiment Station in cooperation with the Division of Biological Control, University of California: *Scymnus*, species not known; *Scymnus binaevatus* (Mulsant) ; and *Scymnus quadrivittatus* (Mulsant). The first species was released in Manoa Valley, Oahu, in January; *S. binaevatus* was released at Makiki and Manoa, Honolulu, in January, in Manoa Valley and in the Foster Gardens, Honolulu, in April, and on Lanai, and again in Manoa Valley in February. *S. quadrivittatus* was released at Manoa in January and May, and at Kunia, Oahu, in March. Details of these introductions are in the files of the Experiment Station, H.S.P.A. It is hoped that these species will become established as predators on some of the mealybugs occurring here.

Dacus dorsalis Hendel—Mr. Zimmerman reported that two adult flies of this species were bred from 97 ripe olives (*Olea europaea*) from the G. R. Carter estate at Kulamanu, Maui, collected November 24. This is a new host record for the oriental fruitfly.

The Insect Guide. Orders and Major Families of North American Insects[1]

(A Review)

By L. D. TUTHILL

In the author's words the purpose of this book is, "to present the insects of North America north of Mexico, in pictures and in non-technical language, at the family rather than at the species level . . ." This purpose is well accomplished. Accepting the fact that the ordinary user of such a guide book will primarily look through the pictures to identify a specimen, Dr. Swain has built the entire book on this basis. There are no keys. The method of use is to look through the plates of illustrations which include at least one representative of each family covered. These illustrations are numbered to correspond to the numbers of the families as given in the text. The illustrations are, fortunately, very good. The colored plates are especially fine.

The introductory section includes a thoroughly condensed minimum of general information on insects and their near relatives, structure, development, behaviour, history, relationships with man and other organisms, and a short section on how to use the book.

Following the treatment of the orders and families, arranged in the usual order beginning with the Apterygota, a chapter on collecting, preserving and studying insects, a well selected list of references, and a good index conclude the volume.

The end papers bear an attractive tabular synopsis of the 26 orders considered in the book. The size of the book is convenient, 7½ x 4¾ inches. It is well bound in an attractive cloth cover.

[1] By Ralph B. and SuZan N. Swain; xlvi+261 pp., 15+48 col. pls. Doubleday and Co., New York, 1948. Price $3.00.

Insects of Hawaii[1]

(A Review)

By R. H. VAN ZWALUWENBURG

This excellent work is the result of over fourteen years of scholarly effort by an author well qualified to bring together and to interpret the great mass of information on the insects of these Islands which has accumulated since the publication of "Fauna Hawaiiensis" nearly half a century ago. "Insects of Hawaii" is the result of cooperation by three scientific agencies in the Territory: the Bernice P. Bishop Museum, the Experiment Station, Hawaiian Sugar Planters Association, and the University of Hawaii, all of which contributed financially or otherwise to its production. It is the third publication to appear under the auspices of the recently created University of Hawaii Press.

For some fifty years "Fauna Hawaiiensis" has been the sourcebook of Hawaiian entomology. Useful though the "Fauna" will always be, so much new information has been gathered, and so many new insects, both native and immigrant, have been found here since its publication, that it is no longer adequate for the student whose first problem often is to know just what species he has in hand. So these volumes fill a real need, and indeed, are indispensable. They not only offer workable keys for identifying the local fauna, but in addition are a storehouse of information concerning the biology of the Hawaiian insects, their origins, importance to agriculture and health, their natural enemies, and, in the case of economic species, their control. The assembling of so much widely scattered, and often inaccessible data between the covers of a few volumes is a concrete contribution to Pacific biological science.

The five volumes consist of some 1700 pages; they contain some 3000 illustrations and about 275 keys for insect identification. The taxonomic pages treat in progressive order from the primitive to the more highly developed orders, the groups from the Thysanura through the mealybugs and scale insects. Later volumes, for which the groundwork has already been done, will discuss in similar manner the rest of the insect orders: the minor orders not previously considered, and the Lepidoptera, Coleoptera, Hymenoptera and Diptera.

In the chapter on the geological history of Hawaii in his "Introduction," the author discusses in clear, yet detailed fashion, the formation of the islands, their degradation (by marine action and erosion), their partial submergence and re-emergence, the age of the island chain and the comparative ages of the individual islands. In the chapter on "Dispersal" are discussed the means whereby plants and animals are spread about the world. The greatest hazard en-

[1] By Elwood C. Zimmerman. Vol. 1, Introduction, xx+206 pp. $3.50; Vol. 2, Apterygota to Thysanoptera inclusive, viii+475 pp. $5.50; Vol. 3, Heteroptera, i+255 pp. $4.50; Vol. 4, Homoptera: Auchenorhyncha, vii+268 pp. $4.50; Vol. 5, Homoptera: Sternorhyncha, vii+464 pp. $6.00. University of Hawaii Press, 1948. Honolulu.

countered by an immigrant species, it is pointed out, is its successful establishment in a foreign and often hostile environment; the percentage of failures is extremely high. Analysis of the native Hawaiian fauna leads the author to conclude that ". . . only about 250 overseas stragglers succeeded in becoming established . . . perhaps one successful colonization per 20,000 years!" From these few successful immigrants has the native Hawaiian insect fauna developed. Parenthetically, it is interesting to compare the meager success of insect immigration unaided by man, with the situation today. In spite of quarantines, not less than 45 immigrant insect species have arrived in Hawaii and established themselves here within the past four years.

In the chapter on "Analyses and Summaries of the Hawaiian Biota," Mr. Zimmerman points out that the number of indigenous insects is small in comparison with the endemic species; the latter approximate 99 per cent of the native species. Nearly two-thirds of the major insect groups known in the world are entirely absent from the native Hawaiian fauna, and these absentees are mainly among the geologically ancient orders. "There is no evidence whatsoever to indicate that there was any Hawaiian continental land mass or that these islands were ever connected by dry land to any continent. The very character of the fauna expresses the essence of oceanic isolation." The affinities of the native insects are over 90 per cent Pacific, and it is "noteworthy that most of the American elements are large, strong-flying insects." This chapter includes a summary of the Hawaiian land shells, and an essay by Dr. F. R. Fosberg on the "Derivation of the Flora of the Hawaiian Islands." The island plants parallel the insects in their origins, development and distribution.

The chapter on "Development of the Endemic Fauna" discusses the complex effects on speciation of repeated invasion and re-invasion of the individual islands, which will especially appeal to the student of evolution. Isolation of small populations on separate islands has resulted in the development of more species than would probably have resulted had the islands been joined in a single land mass. Not only well-reasoned and lucid, but at the same time highly readable, is the author's presentation of such topics as flightlessness, independent origins and developments, predacity and parasitism in the aboriginal fauna, centers of development and rate of evolution, and extinction of species in modern times. Mr. Zimmerman's "Introduction" is one of the most comprehensive and searching treatments of the problems of evolution under island conditions ever presented.

The taxonomic volumes contain a wealth of identification keys. They are profusely illustrated with at least one representative figure of each genus, and include numerous drawings by such superb entomological artists as Dr. Ferris, Mrs. Abernathy and Arthur Smith. The illustrations set a high standard of excellence, and leave little to be desired. Every student of Hawaiian entomology will want to have these indispensable volumes in his working library.

Recent Changes in the Parasite Complex of Armyworms

By FRED A. BIANCHI

(Presented at the meeting of May 10, 1948)

It is a matter of repeated observation in the field of entomology that the most common and obvious phenomena fail to be recorded. As these are often *ipso facto* phenomena of the greatest biological and economic interest, neglecting them may easily result in confusion or unnecessary work for future entomologists. To prevent such an occurrence in connection with one of the Territory's oldest and most important problems, certain changes in the parasite complex of armyworms are here recorded.

These changes have been observed only on the island of Hawaii, where they appeared in connection with a fairly severe infestation of *Laphygma exempta* (Walker) during the first four months of 1948, but it is probable that they have also taken place on other islands. They involve the apparent elimination from the complex of some parasites of earlier introduction and their substitution by two braconids, *Apanteles marginiventris* Cresson and *Meteorus laphygmae* Viereck, introduced from Texas in 1943, and the self-introduced immigrant tachinid, *Eucelatoria armigera* (Coquillett), which was first discovered on Oahu in 1942. These three species, to judge from their relative abundance, now rank in the complex in the order given, and their effectiveness far exceeds that of all the other larval and pupal parasites combined. Whether their effectiveness is also greater than that of the two egg parasites *Trichogramma minutum* Riley and *Telenomus nawai* Ashmead is not shown by our observations but appears possible.

The principal older established larval and pupal parasites, judging again by their abundance in the cane fields of the "Big Island" during the early part of 1948, now rank as follows: *Hyposoter exiguae* (Viereck), *Chaetogaedia monticola* (Bigot), *Frontina archippivora* Williston, *Archytas cirphis* Curran, and *Euplectrus platyhypenae* Howard. *Hyposoter, Chaetogaedia,* and *Frontina* are fairly common everywhere. *Archytas* is scarce everywhere but, as has always been the case, is still more easily found in the region of Kapoho than elsewhere. *Euplectrus,* which formerly ranked first or second in the complex, is now so scarce that only a single instance of its work has been observed by the writer this year.

Proc. Hawn. Ent. Soc., Vol. XIII, No. 3, March, 1949.

New Thrips Records and Species from the Marianas

By F. A. BIANCHI

(Presented at the meeting of July 12, 1948)

An interesting new tubuliferan thrips from Guam is described in this paper, and several new distributional records are given for the Marianas of terebrantian species which are, or may become, of economic importance. I am grateful to N. L. H. Krauss and F. C. Hadden for the material upon which most of these records are based, all of which is now deposited in the collection of the H.S.P.A. Experiment Station, Honolulu.

Suborder TEREBRANTIA

Family THRIPIDAE

Thrips leucaenae Moulton

Described from Guam and known hitherto from nowhere else. Collected at Susupe, Saipan, by N. L. H. Krauss, April 1, 1946.

Thrips tabaci Lindeman

To my knowledge, unrecorded hitherto from the Marianas. Found by F. C. Hadden on onion plants, on Tinian, March, 9, 1946.

Thrips panicus Moulton

Unrecorded hitherto from the Marianas. Collected by F. A. Bianchi at the airport, Guam, January 2, 1947, on grass.

Taeniothrips setipennis (Karny)

Known in the Marianas only from Guam. Collected by N. L. H. Krauss at Susupe, Saipan, April 1, 1946.

Frankliniella sulphurea Schmutz

Hitherto unrecorded from the Marianas. Collected by F. C. Hadden on pepper plants at Tinian, February 21, 1946; and by N. L. H. Krauss at Susupe, Saipan, April 11 of the same year. Mr. Krauss has also given me material of this species which he collected on Johnston Island, May 1, 1946.

Suborder TUBULIFERA

Family PHLAEOTHRIPIDAE

Subfamily PHLAEOTHRIPINAE

Haplothrips gowdeyi (Franklin)

This cosmopolitan species has been recorded previously only from Guam. F. C. Hadden found it on Tinian, February 21, 1946; and N. L. H. Krauss in Susupe, Saipan, April 26, 1946.

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Hoplothrips fungosus Moulton (Plate VIII; figs. A-D)

This interesting little species was described from Formosa (Trans. Nat. Hist. Soc. Formosa, **18**: 305, 1928) and has not been reported elsewhere up to now. In April 1946 Mr. Noel Krauss collected six females and two males—host unreported—at Talofofo, Guam, and kindly gave me the entire lot. Unaware that the species was already known, I had prepared an illustrated description of it when Dudley Moulton helped me determine its true identity, during a visit which I paid him in August 1948. I now append to this paper the illustrations which were to accompany my description of the species as a new one.

Symphiothrips alifanensis sp. nov. (Plate VIII; figs. E-G)

Male holotype (apterous): Body length 1.79 mm. Color by transmitted light: head, thorax, hind and middle tibiae, first two abdominal segments brown; abdominal segments 3 to 10 nearly black; fore-legs uniformly yellowish brown; hind and middle femora yellowish brown, lighter distally; all tarsi light except for distal macula. Sub-hypodermal pigment bright red, abundant on thorax and head. Antennal segment 1 pale yellow; 2 light brownish yellow; 3 slightly darker than 2, except in basal third which is like 2; 4 intermediate between 3 and 5, 6, 7 which are uniformly dark brown.

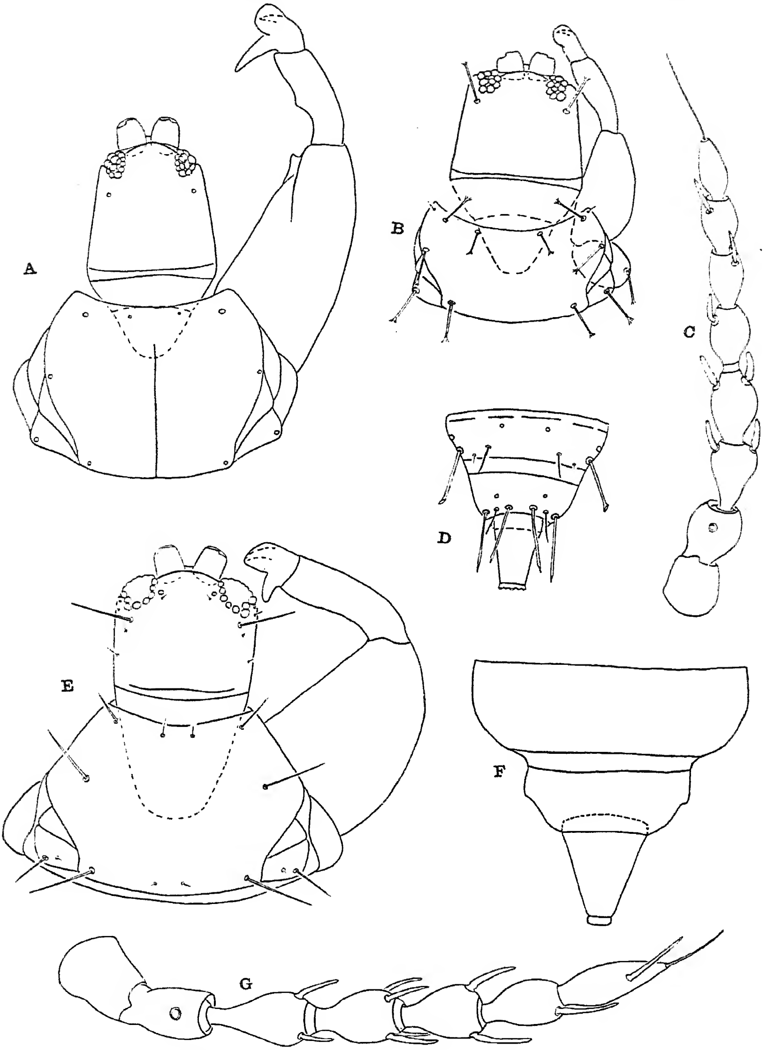
Head a little wider than long, with cheeks and vertex weakly arched. Cheeks with only one or two very fine hairs. Eyes small, rounded dorsally and ventrally, finely faceted except for a few large facets dorso-caudally. Ocelli vestigial, the posterior pair near to the inner margins of the eyes, the anterior one not discernible. Postocular spines somewhat longer than eyes and inserted about a third of their length from the cheeks, about half that distance from the eyes. Mouth cone large, reaching beyond middle of prosternum and broadly rounded at end; labrum attaining, but not surpassing labium; maxillary palpi long and thick.

Antennae more than twice as long as head, inserted under vertex, shaped as illustrated; inter-antennal costa barely surpassing vertex, weakly concave at end and much narrower than basal antennal segments. Segment 7 with an incomplete, oblique suture visible ventrally near middle of segment. Sense cones relatively long and thin: 2 on segment 3; 4 on segment 4; 2 on segment 5; 1 long thin one on inner distal angle of segment 6; 1 dorsally on segment 7.

Pronotum with fore and hind margin weakly arched; sides strongly divergent to about middle and thence nearly parallel to hind angles; mid-dorsal suture not apparent; paired setae at posterior angles and midlaterals nearly equal; antero-angulars smaller; antero-marginals minute; coxals long and stiff; all setae brownish yellow. Forelegs very powerful, with the femur as wide or wider than head and a powerful spur on basal segment of tarsus. Hind and middle legs normal, with hind ones noticeably longer.

Abdomen as wide as thorax to middle of segment 7, thence roundly narrowed to base of 8 whose sides are also rounded; sides of 9 parallel in basal half, forming a distinct angle in the middle, thence sharply convergent to base of tube. Tube typical of genus, wide at base, sharply reduced to narrow end, very heavily chitinized, asperate, minutely setigerous. Terminal setae very weak and short, not much longer than terminal width of tube. Dorsolaterals on segment 9 nearly as long as tube. Other setae of abdomen also long, pointed.

Measurements of holotype in mm.: Head length .143; head width .164; prothorax length .205; prothorax width including coxae .445; width of femur



A. **Hoplothrips fungosus** Moulton: head, prothorax, foreleg of male; all setae omitted.
B. **Hoplothrips fungosus** Moulton: head, prothorax, foreleg of female, with major setae.
C. **Hoplothrips fungosus** Moulton: dorsal view of left antenna of female; setae omitted.
D. **Hoplothrips fungosus** Moulton: dorsal view of 8th, 9th, 10th abdominal segments of female.
E. **Symphiothrips alifanensis** sp. nov.: head, prothorax, foreleg of male.
F. **Symphiothrips alifanensis** sp. nov.: 8th, 9th, 10th abdominal segments of male, all setae omitted.
G. **Symphiothrips alifanensis** sp. nov.: left antenna of male, dorsal view, setae omitted.

.143; eye width and length (approx.) .041; tube length .131; tube width at base .094; tube width at end .032; postocular setae (approx.) .049; antero-angular setae on prothorax .036; antero marginals .020; midlaterals .053; inner setae on posterior angles .057; outer setae on posterior angles .041; coxals .041; dorso-laterals on segment 9, .102; distals on tube .036.

Antennal segments	1	2	3	4	5	6	7	Total
	.041	.041	.057	.045	.045	.045	.061	.335

Described from the holotype, collected by N. L. H. Krauss on Mt. Alifan, Guam, April 1, 1946. Named after the type locality.

To judge from descriptions alone, this new species must be a near relative of the genotype *S. punctatus* Hood and Williams, described from Florida. The two species are similar in habit and size but in *punctatus* coloration and antennal measurements are different, the major setae are mostly capitate, and the mouth cone is pointed.

Dacus dorsalis Hendel, in Hawaii

By D. T. FULLAWAY

(Presidential address, presented at the meeting of December 13, 1948)

Since the discovery of the oriental fruitfly, *Dacus dorsalis* Hendel, in Hawaii, in May of 1946, it has received more attention from entomologists here than any other insect. A great deal of information has been collected in regard to the fly's identity, geographic range and distribution, life-history, habits, hosts (ecology), control, both artificial and biological, economic importance, etc. This information I have collected and put into form for publication as a report of the work that has been the main occupation of myself and associates during the past year or two. In view of the great interest displayed in the matter by the public and profession alike, I thought it might be an appropriate subject for the presidential address this year. I am not, however, going to tire you with the full details, but will give you as briefly as possible the essential facts related in the report.

Identity of the fly. It was apparent at once on examination of prepared specimens that the fly belonged to what is known as the "*ferrugineus* complex" and fortunately we had in our library Shiraki's work on the fruit insects of Formosa containing a brief account of *Dacus ferrugineus* var. *dorsalis* with illustrations in color from which we could, to our own satisfaction at least, determine the identity of our invader. Later on it was desired to have confirmation of our determination by a recognized expert and specimens were sent to Dr. Alan Stone of the U. S. National Museum, who verified the identification by comparing the specimens sent in with material obtained from the Berlin Museum where Sauter's Formosan insect collections repose. It is not believed there is any question at present about the identity of the fly that is doing so much damage to our fruits, but it is still an unsettled point whether the species or variety *dorsalis*, which was described by Hendel from specimens collected in Formosa, is extensive or restricted in range. If *dorsalis* is considered as a component of the *ferrugineus* complex, there is no question about it or its closely allied forms ranging from India in the west to Australia in the east, and from Java in the south to Formosa or even Kyushu in the north. Bezzi in his monograph on the Philippine trypetids lists *dorsalis* as occurring in a number of oriental countries but we have been unable to identify it positively in the collections from the Orient we have had. The question is more or less academic for the present.

While the presence of *dorsalis* in Hawaii was not recognized until May 10th, 1946, there seems to be no question about its having been here unrecognized more than a year previous to that date. O. C. McBride has stated that he found one female specimen of *dorsalis*

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amongst 22,500 flies reared or collected between April and July 1945, and in view of the fact that the fly has been known to be on Saipan for a decade or more, and that our armed forces returned to Hawaii after the conquest of this island, circumstantial evidence points to their being responsible for transporting the insect to our shores, probably in infested fruits.

Life history. There is nothing unusual in this fly's development. In cage rearings in our laboratory a period of 16 days was required for development from deposition of the egg to emergence of the adult fly, in bananas; 23 days for similar development in papaya, both records made in the summer months when development is expected to be fastest. Duration of the different stages, in the spring months, averaged less than 2 days for the egg, 16 days for the larvae, 9 days for the pupae, but in one rearing, larval development was completed in 9 days. This stage shows greatest variation, and apparently under some conditions can be greatly prolonged. We found the length of life of the adult fly unpredictable but as a general rule flies can be maintained alive much longer when properly fed and cared for. In one experiment begun with 50 females and 50 males, all fed on papaya juice diluted with water and sweetened with honey, highest mortality occurred in the third week of the experiment; one individual, a female, lived through 86 days. We have found the preoviposition period to range from 8 to 16 days, although another investigator states that 29 to 32 days (in Sept. and Oct.) and 34 to 39 days (in May and June) were required to mature the eggs. One worker has recorded observing mating an hour after darkness had set in, 22 days after the emergence of the flies. In an experiment begun with gravid females to check on oviposition habits and capacity we observed that even with ripe fruits the fly carefully explored the surface for soft spots where the ovipositor could be inserted readily, and advantage was taken of bruises, cracks and very thin areas of the skin. Where there was internal pressure to oviposit, eggs often to the number of several hundreds were laid at one time but ordinarily the number was limited to less than 10. Another investigator states that working with flies individually confined the highest daily total obtained was 37 eggs and the highest 7-day total for an individual fly was 101 eggs. Where in nature a larger number of eggs is found in one pocket or break in the skin of the fruit, it is realized it may be the deposit of several females. Early in our experience with this fly it was discovered that citronella oil exerts a decided attraction for the male flies. This peculiar quality of the oil has little significance in control operations and except to help judge the effectiveness of poison sprays in reducing fly populations in a given locality or estimating size of populations the oil has little practical use. It should be mentioned here that examination of thousands of reared specimens of the fly showed that males and females maintained about even numbers in the count. Flies trapped with citronella oil, being overwhelmingly males, presumably represent only about half the population. Another experiment planned

to obtain a check on the percentage of flies successfully passing through developmental stages on the basis of host fruit in which development took place, gave such varying results—from 37 per cent for *Opuntia* fruits to 99 per cent for papayas—that little significance is seen in the results obtained.

Many of the observations made by Koidsumi and Shibata in their ecological studies of the fly in Formosa have been verified here and I believe it is worth while to include here some of their findings as given in the review of their work which appeared in the Review of Applied Entomology. They found the adult flies more active than those of *D. cucurbitae* and believed it necessary to provide more space for them to move in when observing their habits. Emergence of the flies was observed to occur generally before noon and they believed the flies to be most active at 77-86° F., becoming dormant when the temperature dropped below 68° F. They found the flies lived about a week, without ovipositing, when given water only, and for a month when fed on honey. They lived much longer and laid eggs when fed on banana and other fruits. Oviposition began 20 days after emergence in summer, 25-60 days in autumn and 100 in winter, when the flies were fed on orange juice. Females that were about to oviposit drove away others from the fruits. According to these observers *dorsalis* females lay fewer eggs in a fruit than *cucurbitae,* only 20-30 larvae being usually found even in a large fruit as compared with 200-300 of the latter species, a single egg cavity generally containing 5 to 10 eggs. The number of eggs laid by a single female is usually 500 and sometimes 1000. Even citrus fruits that are strongly acid (pH 2.2-2.7) were sometimes attacked and larvae were able to mature in them. Flies in captivity laid eggs in ripened papaya, bruised pineapple, banana, pear, apple and persimmon and the larvae matured in all except the last two, although they are not usually attacked in the field. Captive flies laid eggs in lemon but the eggs or newly hatched larvae succumbed in the unfavorable environment. In the northern part of Formosa the flies remained dormant in winter. Though emergence from the pupae was observed to take place, eggs and larvae did not develop.

One of the most striking evidences of *dorsalis'* superlatively aggressive qualities is the gradual disappearance of the Mediterranean fruitfly *Ceratitis capitata* (Wied.). In regions like the Honolulu city area where fruit-bearing trees are everywhere present and *dorsalis* populations high, *C. capitata* has totally disappeared. This is not a notion; one has only to consult the year's record of rearings from fruit collected in Honolulu to see how nearly accurate this statement is.

Much time has been spent in collecting host fruit records for *dorsalis*. The list far surpasses in length the list of *C. capitata* hosts. Ninety-three fruits are now listed and most of the common fruits of the islands are included. The cucurbit fruits are notice-

ably absent and the common assertion that the fly shows no selectivity is not entirely true. Reference has been made earlier to a record of rearings of flies from various fruits. This record covers more than a year's study (reported on monthly) of the number of flies reared from 44 different fruits and data can be obtained from it on the number of flies per fruit and the number per pound in any month of the year when this fruit was available in a condition to become infested. Of course most of the records pertain to the four or five commercial fruits (mango, avocado, papaya, banana, fig) and to several wild fruits which are extremely common (guava, kamani and *Eugenia* spp.). It is believed that by and large the heaviest fruit production occurs in the summer months and one of the commonest fruits at this time is the mango. *Dorsalis* has ruined the mango crop for several years and in view of the great number of seedling trees everywhere the fly will surely continue to build up large populations every summer. It was very noticeable in the past summer how decidedly the fly population dropped when the mango fruit season was over. There are some data in this record showing a positive relationship between the size of the fruit and the number of flies produced but it is not consistently evident throughout, mainly because of other factors entering into consideration. The record will be particularly valuable when parasites and predators introduced to control the fly begin to have an effect on the size of the populations. Fortunately for the success of the biological control project there are some fruits both wild and cultivated that mature regularly in the fall and winter months and some that have early and late fruiting varieties and some of the most useful fruits for the propagation of the parasites often bear several crops during the year according to the vagaries of weather conditions and also where irrigation is practiced. My observation is that fruits must be approaching maturity before oviposition succeeds in it. No doubt attempts are made by flies heavy with eggs to oviposit in immature and green fruits but if the fruit is hard the skin cannot be readily penetrated; if ripening has not begun the eggs will be expelled, or crushed, or drowned in the sap, or vitiated by some deleterious agent such as a protolytic enzyme.

Economic importance of the fly. Although the oriental fruit-fly attacks so many fruits it is easier to name the ones it is not reared from than those it is, the economic importance of the fly is posited in its destructiveness to the commoner marketable fruits, such as the mango, avocado, banana, papaya and fig, and its menace to fruit growers in California and the American states of the Gulf Coast, where citrus fruits, a favored host in Formosa, are the big item in fruit production. Fortunately, it does not normally attack the pineapple, the one fruit of really great economic importance in Hawaii—60 million dollars yearly—(it has been reared from overripe pineapple both here and in Formosa). Export of fresh fruit, even pineapples and bananas which previous to 1940 were shipped to the west coast of America in considerable volume,

is now prohibited by federal quarantines unless the fruit is treated in such a way that all developmental stages of the fly—eggs, larvae, pupae—are killed, an expensive procedure seriously limiting its application. Besides the spoilage in edible fruit caused by injury to it by the fly in depositing its eggs and the worms developing therefrom in feeding on the pulp—a loss which can be great in tropical and semitropical climes with a fly of *dorsalis'* potentialities —injury has also been observed to the blooms of orchids and gingers which emit fragrant odors, attracting the male flies of *D. dorsalis.* The injury is in the nature of a spotting which results from tissue destruction beneath droplets of regurgitated liquid food dried too rapidly by the sun, and affecting adversely the saleability of the flowers.

Measures taken to control the fly. Mechanical. Bagging fruit to prevent access to it by the ovipositing female, is a very practical measure but it has its limitations. Mangoes, avocadoes and figs can usually be covered with bags and even tomatoes and other small fruits are similarly protected. Trapping has generally given poor results, as a good bait or lure has yet to be found.

Chemical. It has been found by experiment that wettable DDT spray gives protection to ripening fruit for at least one week. This is considered much safer than the old Mally formula of arsenic, molasses and water.

Many of the control measures found suitable in other fruit growing countries appear to be inapplicable here mainly on account of the abundance of wild fruits present, often growing in inaccessible places, which keep the fly population going in spite of any repressive measures taken. For instance, clean culture; this familiar procedure was given a trial when the Mediterranean fruitfly appeared in Hawaii in 1910-11 but proved ineffectual. With its failure recourse was had to biological control.

Biological control. Considerable was already known about fruit fly parasites and predators in the Orient from previous exploration there, and in numerous consignments of fruitfly material from the Philippines and Malaya three opiine parasites and one tetrastichine parasite have been generally reared. These are *Opius longicaudatus* (Ashmead), *O. persulcatus* (Silvestri), *O. incisi* Silvestri and *Syntomosphyrum indicum* Silvestri. The first named has been successfully propagated and many thousands liberated on the principal islands. Its recovery from the field has been effected in many instances on Oahu and its establishment is well nigh certain. The others have all been reared in *dorsalis* larvae but have not reproduced very well. Predators are also being introduced, particularly staphylinid beetles (one is being propagated and liberated from time to time). It is believed that eventually an effective control of the fruitfly will be obtained by the various means above detailed.

Identity of the Anagyrus that Parasitizes the Pineapple Mealybug (Hymenoptera: Chalcidoidea: Encyrtidae)

By A. B. GAHAN

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(Presented by Dr. Carter at the meeting of August 9, 1948)

In 1936, I received from D. T. Fullaway three specimens of an *Anagyrus* which he had reared from the pineapple mealybug, *Pseudococcus brevipes* (Ckll.) collected in Brazil. I identified the parasite as probably *Anagyrus coccidivorus* Dozier, and under this name its successful introduction into Hawaii and attempts to introduce it into Puerto Rico have been recorded in the literature.

Anagyrus coccidivorus Dozier (Proc. Ent. Soc. Wash., **34**: 8, 1932) was described from Haiti as a parasite of *Ferrisia virgatus* (Ckll.). Biological studies by D. W. Clancy and H. N. Pollard (1947) indicate that the *Anagyrus* from *P. brevipes* will not reproduce upon *F. virgatus* and, hence, that it is probably not *A. coccidivorus*. A recomparison of specimens of the pineapple mealybug parasite with the type of *coccidivorus* shows certain slight differences which were not considered significant at the time of the first comparison, but which now appear to be constant for a long series of specimens and to confirm the conviction that this parasite is not *coccidivorus*. Since it does not appear to agree completely with any known species, it is herewith described as new.

Anagyrus ananatis, new species.

Anagyrus sp. Compere, Hawaii. Ent. Soc. Proc., **9**: 171, 1936; Carter, idem: 366, 1937.

Anagyrus coccidivorus Dozier (Misidentification of). Carter, Jour. Econ. Ent., **30**: 370, 1937; Hawaii. Ent. Soc., Proc. **10**: 3, 1938; **12**: 489, 1946.—Schmidt, Hawaii. Ent. Soc., Proc. **10**: 194, 1939.—Plank, Puerto Rico Agr. Expt. Sta. Rpt., for 1937, p. 98, 1938; for 1938, p. 107, 1939.—Bartlett, Puerto Rico Univ. Jour. Agr., **23**: 70, 1939.—Swezey *et al.*, Hawaii. Ent. Soc., Proc. **10**: 352, 1939.—Anonymous, Puerto Rico Agr. Expt. Sta. Rpt. for 1939, p. 109, 1940; for 1940, p. 69, 1942.—Clancy and Pollard, Jour. Econ. Ent. **40**: 579, 1947.

Belongs to the group of species having the entire flagellum, with the exception of the first funicular segment, white. Many species of the genus fall in this group, but in the majority of these the entire first funicular segment is black, whereas in this new species only the basal half or less of the first segment is black. This character,

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together with the absence of any pale longitudinal streak on the inner side of the scape, will distinguish it from *coccidivorus* Dozier, with which species it otherwise agrees very closely.

Female—Length 1.8 mm. General color orange-yellow more or less strongly diluted with blackish. Fronto-vertex and face for the most part bright orange; posterior margins of temples and cheeks black or blackish; occiput mostly black, but with a marginal border above and at sides slightly paler yellowish than the frons; mandibles dark reddish apically, the mouthparts otherwise pale yellow. Antennal scape dull black, except for a small round spot at extreme base and a broad transverse apical band of white; pedicel black at base, the apical half white; first funicular segment black basally with the apical half or two-thirds white; remainder of funicle and all of the club white; eyes grayish. Dorsum of thorax varying from bright orange with only a slight undertone of blackish, to very dark reddish brown or nearly black, the dorsal aspect of pronotum usually concolorous with mesoscutum, but occasionally somewhat more pallid; scutellum with a blackish median streak extending approximately half its length from its base; tegulae whitish basally, brownish apically, in dark specimens mostly dark brown; prepectus, metanotal sutures and middle of propodeum more or less whitish; sides of prothorax, mesopleura, metapleura and all sterna pale orange in the type, ranging to dark or dirty orange in other specimens; legs including coxae whitish, usually stained with fuscous along the dorsal and ventral margins of femora and tibiae; propodeum pale medially, black laterally; abdomen black or dark brown above, the gaster sometimes more or less orange beneath. Wings subhyaline, the venation fuscous.

Fronto-vertex about one and one-half times as long as its narrowest width, opaque; ocelli in a nearly equilateral triangle, the lateral ocelli very slightly farther from each other than from anterior ocellus; ocell-ocular line about equal to diameter of an ocellus and about equal also to the distance from ocellus to occipital margin. Mandibles bidentate, the upper tooth rounded at apex, the inner tooth much smaller, shorter and sharp. Antenna not quite so long as the body; scape not reaching level of anterior ocellus, expanded below, about twice as long as broad; pedicel about three times as long as broad at apex; first funicular segment usually a little longer than pedicel, never shorter; funicular segments beyond the first successively shortening slightly, the sixth about twice as long as thick; club distinctly 3-segmented, very slightly thicker than funicle and a little longer than two preceding segments. Eyes with short pile. Mesoscutum, axillae, and scutellum rather densely clothed with short silvery hairs, the scutellum also with three to four pairs of black bristles, the two pairs nearest apex long and subequal, the third pair from apex usually considerably shorter, and the fourth pair when present quite short and inconspicuous. Propodeum short with fine granular sculpture and clothed with short silvery hairs laterally. Abdomen about as long as head and thorax, acute at apex, finely sculptured, and clothed with short whitish hairs; ovipositor not exserted. Spur of middle tibia equal to basal segment of tarsus. Forewing extending a little beyond apex of abdomen; uniformly and rather densely ciliated, except for the hairless streak which is broadly interrupted behind the middle; stigmal vein twice as long as marginal, postmarginal very short, much shorter than stigmal.

Male—Length 1.0 mm. Head, thorax and abdomen dull black; prepectus white; sides of prothorax and broad band along anterior margin of mesopleura orange; tegulae white basally, blackish apically; legs including front coxae white with some fuscous stains; hind coxae black and middle pair blackish. Antennal scape white at base and apex, black medially; pedicel black, usually paler at apex; flagellum dirty whitish, except first segment which is blackish basally. Wings hyaline, venation fuscous.

Scape short, expanded beneath, about twice as long as broad; pedicel about as broad as long; flagellum of a uniform thickness, clothed with coarse blackish hairs, its first segment approximately five times as long as thick and one and a half times as long as second segment, following segments gradually diminishing in length, the sixth about twice as long as broad; club tapering slightly toward apex and a little longer than the two preceding segments. Fronto-vertex a little broader than long. Abdomen triangular, shorter than thorax.

Type locality—Rio de Janeiro, Brazil.
Type—United States National Museum No. 58832.

Described from 81 ♀s and 5 ♂s, all reared from the pineapple mealybug, *Pseudococcus brevipes* (Ckll.). The holotype female and 5 ♀ paratypes are from the type locality, reared by D. T. Fullaway in January and February, 1936; 2 ♀s are from Recife, Brazil, reared by C. T. Schmidt, January 1, 1947; 10 ♀s were reared in November 1946, as progeny of stock collected at Bahia, Brazil, by W. Carter; the allotype male, 4 ♂ paratypes, and 63 ♀ paratypes were reared from *P. brevipes* collected in the field at Lahaina, Maui, Territory of Hawaii, in December 1947, by W. Carter, and are descendants of the original importations from Brazil.

Anagyrus dactylopii (Howard)

Aphycus dactylopii Howard, Proc. U. S. Nat. Mus., **21**: 242, 1898.
Anagyrus dactylopii (How.) Timberlake, Univ. Calif. Pubs. Tech. Bul., **3**: 224, 1924.

This species is very similar to *ananatis*, from which it can be distinguished by the first funicular segment being distinctly shorter than the pedicel and entirely black or blackish. The other joints of the funicle are also shorter than in the new species.

Anagyrus yuccae (Coquillett)

Blastothrix yuccae Coq. West American Scientist, **7**: 44, 1890.
Epidinocarsis subalbicornis Girault, Psyche, **23**: 44, 1916. (New synonymy.)
Anagyrus yuccae (Coq.) Timberlake, Univ. Calif. Pubs., Ent. **3**: 224, 1924.
Anagyrus subalbicornis (Gir.) Timb. Univ. Calif. Pubs., Ent., **3**: 224, 1924.
Anagyrus ferrisi Compere, Univ. Calif. Pubs., Ent., **4**: 18, 1924. (New synonymy.)
Anagyrus subalbicornis (Gir.) Compere, Univ. Calif. Pubs., Ent., **8**: 21, 1947.

I can see no differences between the types of *Blastothrix yuccae* Coq. and *Epidinocarsis subalbicornis* Gir., both of which are in the National Museum collection. Compere suppressed his *Anagyrus ferrisi* as a synonym of *subalbicornis,* but maintained *yuccae* as a good species chiefly on the basis of Coquillett's statement that there were eight long black bristles on the apex of the scutellum. I have

carefully examined Coquillett's type specimen and find only three pairs of bristles on the scutellum, exactly as in the types of *sub-albicornis* and *ferrisi*.

A. yuccae is extremely close to *A. bohemani* (Westwood) as represented by a single European female specimen identified by G. Mayr. This specimen appears to be a little more uniformly black on the dorsum, and I can see only two bristles at the apex of scutellum. Otherwise I cannot distinguish it. Mayr's description of *bohemani*, however, points out so much variation that I am led to suspect that he may have included more than one species in *bohemani*, and hence, do not feel certain that this specimen is correctly identified.

Anagyrus schönherri (Westwood)

Encyrtus schönherri Westwood, Philos. Mag. (3 ser) **10**: 441, 1837.

Blastothrix schönherri (Westw.) Mayr, Verhandl. Zool.-Bot. Gesell. Wien, **25**: 699, 1875.

Anagyrus schönherri (Westw.) Mercet, Fauna Iberica, p. 243, 1921.

Anagyrus flavus Ishii, Bul. Imp. Agr. Expt. Sta. Japan, **3** (2): 86, 1928 (New synonymy).

I can see no differences between a specimen from Germany identified by Mayr as *Blastothrix schönherri* (Westwood) and specimens from Japan reared by C. L. Marlatt from *Pulvinaria* sp., which appear to me to agree perfectly with the description of *Anagyrus flavus* Ishii. I believe *flavus* Ishii to be a synonym of *schönherri* (Westwood).

Two New Wasps from Melanesia and Notes on a Third Recently Introduced into Hawaii (Hymenoptera: Sphecidae)

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(Presented by Mr. Van Zwaluwenburg at the meeting of August 9, 1948)

The new species described herein are based on material in the U. S. National Museum and loans received from the Hawaiian Sugar Planters' Association through E. C. Zimmerman and from the British Museum (Natural History) through R. B. Benson. Dr. F. X. Williams and Mr. Benson of the last two institutions respectively have very kindly compared specimens of *Pison* with species in the collections under their care.

Pison insulare Smith

Pison insularis Smith, 1869. Trans. Ent. Soc. London, p. 297. (♀; New Hebrides; type in British Museum.)—Turner, 1916. Proc. Zool. Soc. London, p. 626. (Treated as specifically distinct from *priscum* Turner.)

Pison insulare Smith, Dalla Torre, 1897. Cat. Hym. **8**: 711.—Turner, 1908. Proc. Zool. Soc. London, p. 510. (Comp. with *insulare priscum*, n. subsp. from Australia.)—Cheesman, 1937. Ann. Mag. Nat. Hist. (10)**20**: 203. (♀, ♂; Malekula, Espiritu Santo, Erromango, Tanna, Aneytioum, Efate and Gaoua, all islands in New Hebrides; addit. descr.).

Pison sp., Weber, 1948. Proc. Hawaii. Ent. Soc. **13**: 222. (Kawaiiki Trail, Koolau Mts., Oahu.)

In November 1947 P. W. Weber collected four large *Pison* females on Oahu, T. H., which were subsequently submitted to me for identification. Comparison of these specimens with material available from other islands of the Pacific established that these constituted a recent introduction from New Hebrides, being conspecific with a female from Espiritu Santo, New Hebrides, in my personal collection.

The question as to what name should be applied to this species was a puzzle. Only one *Pison*, *insulare* Smith, had been described from New Hebrides, but Williams (1945. Proc. Hawaii. Ent. Soc. **12**: 442) had identified as *insulare* a species from New Caledonia which was quite distinct from the New Hebridean and Hawaiian material mentioned above. Both Williams and I had considered that my specimen from New Hebrides was an undescribed species. However, when this supposed new species turned up in Hawaii late in 1947 further investigation seemed desirable. The descriptions of *insulare* by Smith and Cheesman did not definitely eliminate the New Caledonian species from consideration as true *insulare*, so I sent specimens of each species to Mr. Benson for comparison with Smith's type. He reports (in litt.) "As you suggest the form

from New Hebrides and Hawaii is the true *P. insulare* and the New Caledonian form differs from this in its much denser punctation of propodeum and first tergite." He states further that the species from New Caledonia differed from all others in the British Museum on gross punctation.

Mr. Weber (in litt.) states that the Hawaiian specimens were taken slightly north of the center of Oahu removed from any point of importation, and says further that, "... the wasps could easily have been here for some time and spread that far without being detected. A similar case in point is that of *Chalybion bengalense* which was first recorded from the southwest coast of Oahu at Nanakuli, and shortly after was observed in Manoa Valley, some thirty miles distant." Therefore, *insulare* Smith appears to be an established member of the Hawaiian fauna with the known distribution limited to various islands of the New Hebrides group and Oahu, T. H.

The comparatively large size (♀, 9.5-11 mm. long) readily distinguishes *insulare* from other *Pison* occurring in Hawaii except *hospes* Smith. It is more polished than *hospes,* comparatively much more sparsely punctate (disk of mesoscutum with punctures separated by several times the width of a puncture, middle of dorsal surface of propodeum practically impunctate), only the first two tergites have apical bands of silvery pubescence, and the median lobe of the apical margin of the clypeus in the female is broadly rounded rather than triangular.

I have examined the following material:

NEW HEBRIDES. 1 ♀; Espiritu Santo; September 28-October 7, 1943 (J. G. Franclemont) [KVK]. 2 ♂; same data, but September 1944 (K. L. Knight) [USNM]. 1 ♀; Malekula; January 1930 (L. E. Cheesman) [BM].

HAWAII. 2 ♀; Kawaiiki Trail, Oahu; November 2, 1947 (P. W. Weber). 2 ♀; Anahulu Trail, Oahu; November 30, 1947 (P. W. Weber) [USNM and PWW].

Pison novocaledonica, new species

Pison insulare Williams, 1945. Proc. Hawaii. Ent. Soc. **12**: 442, pl. 24, figs. E, G, H; pl. 25, fig. H. (Misident. of Smith species.)

Structurally this species comes closer to *hospes* Smith than to *insulare* Smith, agreeing with the former in the subopaque integument and relatively stronger and closer puncturation. *P. hospes* differs from *novocaledonica* in the following important particulars: Median impunctate produced area of clypeus triangular; frontal groove from anterior ocellus evanescent; transverse rugae of posterior surface of propodeum stronger and sparser; sternites much more closely punctate, especially the second; only extreme apex of wing infumated.

Type: ♂; St. Louis, New Caledonia; November 26, 1944 (Wilfred Crabb). (U. S. National Museum, Type No. 58814.)

Male—Length 9.5 mm. Black, subopaque except metapleuron, propodeum and abdominal sternites which are shining; tip of mandible dark castaneous, apex of tegula somewhat lighter. Vestiture shining, silvery, short, suberect on head and thorax, decumbent on legs and abdomen, abdominal tergites one to four with noticeable hair bands apically; tibial calcaria black. Wings with apical two-thirds of forewing and apical third of hind wing rather strongly infumated, stigma and veins fuscous.

Head: Impunctate median produced area of clypeus pentagonal in shape; shortest distance between eyes at lower ends (across middle of clypeus) greater than shortest distance between eyes on vertex (5:3); front finely granulate upon which is superimposed moderately large, shallow punctures separated from each other by slightly more than the width of a puncture, a median longitudinal groove running from anterior ocellus two-thirds of distance to antennal insertions and terminating there in a short polished streak (the vestige of frontal tubercle); vertex with punctures somewhat smaller and separated by slightly less than the diameter of a puncture; ocellocular distance half the diameter of a posterior ocellus and less than postocellar distance (5:8).

Thorax: Mesoscutum with punctures about same size as on front, mostly separated by slightly less than width of a puncture; scutellum and postscutellum with smaller punctures, those of former rather sparse in center, those on latter almost contiguous; mesopleuron with punctures somewhat larger than on mesoscutum and about equally spaced; metapleuron punctate-rugulose above and with scattered minute punctures below; dorsal surface of propodeum with a well-developed median longitudinal crenulate groove, laterad of this with punctures arranged more or less in oblique rows and with a faint indication of rugulae, the punctures about as large as on mesoscutum and many of them separated by about the width of a puncture; posterior surface transversely ruguloso-punctate, median impression on upper part moderately broad; lateral surface with subcontiguous punctures becoming somewhat denser to the rear; groove separating lateral from dorsal and posterior surfaces well-marked and extending anteriorly almost to spiracle.

Abdomen: Tergites one to five slightly constricted apically, the fifth very faintly so; puncturation slightly finer than that of postscutellum, punctures of first tergite separated by two or more times the width of a puncture, the density increasing on succeeding tergites, those on the fifth separated by less than twice the width of a puncture; sternites correspondingly much more sparsely punctate, the second with only a few scattered ones discally, laterally with closer ones, the density increasing on succeeding ones; intermediate sternites simple, not tuberculate or ridged, the third to fifth slightly constricted apically; hypopygium shallowly emarginate apically, the lateral angle short, broad, rounded, medianly near apex with a semicircular, rounded impression bordered posteriorly by the apical row of dark stout setae.

Wings: Forewing with petiole of second submarginal cell about as long as height of cell; first recurrent vein interstitial with first transverse cubital, second recurrent vein received in second submarginal cell just before tip.

Male paratypes vary in length from 7.0 to 10.5 mm. and differ from the type in the following structural details: Frontal tubercle usually higher and more elongate; occasionally the median groove on dorsal surface of propodeum bisected in part or entirely by a carina; sometimes the first recurrent is received just before the apex of first submarginal cell; and sometimes the second recurrent is interstitial with the second transverse cubital.

Allotype: ♀; same data as type. (USNM.)

Female—Length 8 mm. (apical abdominal segments somewhat retracted). Similar to type male except as follows: Median impunctate produced area of clypeus broadly rounded; shortest distance between eyes at lower ends (across middle of clypeus) proportionately greater as compared to shortest distance between eyes on vertex (3:2); frontal tubercle higher, more elongate;

ocellocular space one-fourth the diameter of a posterior ocellus, and one-third the postocellar distance; dorsal surface of propodeum lacking any indication of oblique rugulae; groove separating lateral from dorsal and posterior surfaces of propodeum well-marked, but not extending so far forward; only tergites one to three with noticeable apical bands of silvery hair; only first four tergites slightly constricted at apex, the sternites not constricted; second recurrent interstitial with second transverse cubital.

Female paratypes vary in length from 8.5 to 11.0 mm. and differ from the allotype in the following structural details: Median groove on dorsal surface of propodeum rarely bisected by a carina; recurrent nervures occasionally received slightly before the first and second transverse cubitals respectively.

Paratypes: 32 ♂, 30 ♀, all New Caledonia, as follows:

1 ♂, same data as type; 1 ♂, Noumea, October 6, 1944 (Wilfred Crabb); 1 ♀, same data, but December 12, 1944; 1 ♀, Plum Farm, January 3 (W. P. Cockerell) [USNM].

2 ♂ (P. D. Montague); 1 ♀, Noumea, January 20, 1914 (P. D. Montague); 1 ♀, same data, but January 24, 1914; 1 ♂, Bourail, December 1930 (L. E. Cheesman) [BM].

1 ♂, 1940 (F. X. Williams); 1 ♀, Noumea, August 18, 1940 (F. X. W.); 1 ♀, same data, but August 28, 1940; 1 ♀, same data, but September 9, 1940; 1 ♂, same data, but September 17, 1940; 1 ♀, same data, but September 23, 1940; 1 ♂, same data, but September 24, 1940; 1 ♂, same data, but October 13, 1940; 2 ♀, same data, but October 18, 1940; 1 ♂, same data, but October 19, 1940; 1 ♀, same data, but October 1940; 1 ♀, near Noumea, September 12, 1940 (F. X. W., reared from cocoon in mud cell of *Eumenes*); 2 ♂, 1 ♀, hills behind Noumea, October 16, 1940 (F. X. W.); 1 ♂, same data, but October 19, 1940; 1 ♂, 3 ♀, Hienghene, October 4, 1940 (F. X. W.); 1 ♀, same data, but October 5, 1940; 1 ♂, same data, but October 6, 1940; 2 ♂, 2 ♀, Thi River Valley, November 1, 1940 (F. X. W.); 2 ♂, 1 ♀, same data, but November 6, 1940; 2 ♀, same data, but November 8, 1940; 1 ♂, St. Louis, August 17, 1940 (F. X. W.); 1 ♀, same data, but September 25, 1940; 3 ♂, 2 ♀, same data, but October 14, 1940; 1 ♂, same data, but October 29, 1940; 2 ♂, 1 ♀, Nakety, October 9, 1940 (F. X. W.); 1 ♂, 1 ♀, Bonjou District, September 13, 1940 (F. X. W.); 1 ♂, Oua Tom, September 19, 1940 (F. X. W.); 1 ♂, same data, but September 20, 1940; 1 ♂, Prony Bay, October 22, 1940 (F. X. W.); 2 ♀, Nepoui Valley, July 1940 (F. X. W.); 2 ♂, 1 ♀, Isle of Pines, October 24, 1940 (F. X. W.) [HSPA].

Male and female paratypes also have been deposited in the collections of the California Academy of Sciences, American Museum of Natural History, and Museum of Comparative Zoology.

Psen (Psen) cheesmanae,[1] new species

Specimens of this undescribed species were included among some New Guinea and Solomon Islands material sent me by Mr. Benson several years ago. Since I am not including New Hebrides in my

work on the wasps of New Guinea and Solomon Islands I take this opportunity to describe the present form.

Psen bryani Perkins and Cheesman (1928. Ins. Samoa, Part V, Hym., Fasc. **1**: 28) from Samoa is the only other true *Psen* known from the islands of the Melanesian subregion. Endemic species of this genus might be expected to occur on other large island groups of this subregion, such as Fiji and New Caledonia, but as yet none has been collected.

The present species, known only from the male, is distinguished from the male of *bryani* by the following characters: Hind tarsi testaceous (said to be almost black in *bryani*); petiole of first abdominal segment twice as long as first tergite (stated to be one and one-half times as long in *bryani*); and fasciculate hairs at apices medianly of third and fourth sternites extending about one-fifth the width of sternites (said to be one-third in *bryani*).

Type: ♂; [Espiritu] Santo, New Hebrides; August-September 1929 (L. E. Cheesman) [British Museum (Natural History)].

Male—Length 10 mm. Black, the tarsi testaceous; head and thorax, except metapleuron, semi-mat, metapleuron and abdomen shining. Vestiture shining, silvery, very dense on clypeus and front beneath antennae obscuring the puncturation, decumbent except on vertex, dorsum of thorax and propodeum, and longer on mesopleuron and propodeum than elsewhere; fasciculate hairs at apices of third and fourth sternites yellowish. Wings hyaline, veins fuscous, venation apparently as in *bryani*.

Head: Edge of clypeus thickened medianly, slightly emarginate there, not at all strongly produced; frontal carina terminating between antennae in a low rounded, cariniform tubercle; antenna slightly clavate toward tip, tyloides absent, pedicel not hidden in apex of scape, first flagellar segment longer than second or third, but somewhat shorter than second and third together; front above antennae with small punctures, those beneath anterior ocellus about as close to one another as the diameter of a puncture, those on vertex much sparser, usually separated by at least twice the width of a puncture; ocellocular distance very slightly less than postocellar distance (9:10).

Thorax: Pronotum not dentate laterally; mesoscutum with punctures larger than those on vertex, denser anteriorly and separated by about the diameter of a puncture, sparser posteriorly and separated usually by at least twice that distance; scutellum with punctures as on mesoscutum, but more scattered; postscutellum with minute close punctures; disk of mesopleuron with minute, extremely sparse punctures; metapleuron glabrous, impunctate, enclosure on dorsum of propodeum with about ten strong, radiating rugae, lateral surface punctate, posterior surface punctate and with large, irregular reticulations.

Abdomen: Petiole of first segment convex above, laterally with a series of sparse pale hairs, twice as long as first tergite; fasciculate yellowish hairs at apices medianly of third and fourth sternites extending over about one-fifth the width of segments.

Paratype: ♂; Malekula, New Hebrides; December 1929 (L. E. Cheesman) [BM]. Deposited in U. S. National Museum.

The paratype differs from the type in the following details: Length 11 mm.; interantennal tubercle larger; hind legs missing so coloration of tarsi of type cannot be confirmed.

[1] For Miss L. E. Cheesman, collector of many interesting Hymenoptera on the Pacific islands.

The Aculeate Hymenoptera of Micronesia
I. Scoliidae, Mutillidae, Pompilidae and Sphecidae

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(Presented by Mr. Van Zwaluwenburg at the meeting of November 9, 1948)

Prior to World War II the aculeate Hymenoptera fauna of Micronesia had received scant attention. Aside from scattered descriptions of individual species only a few papers have dealt with all the fauna of any island or group of islands. The earliest faunistic paper of any importance is the brief list of Guam Hymenoptera by D. T. Fullaway in 1913, which contains thirteen species of bees and wasps, less than half of them being determined to species. The collecting expeditions of the Japanese entomologists, T. Esaki and K. Yasumatsu formed the basis for a series of papers by the latter on the bees and wasps. The bees of the joint Bishop Museum-Japanese Government expedition to the Caroline Islands in 1936 were treated by T. D. A. Cockerell, who also contributed papers on the bees of Guam and Rota Island collected by O. H. Swezey, E. H. Bryan, Jr., and R. L. Usinger. O. H. Swezey also contributed a short paper on the wasps of Guam. A bibliography of the papers dealing with Micronesian wasps is included at the end of this paper.

It is my intention to bring together the information contained in the scattered papers referred to above, as well as to record a number of new endemic species and recently introduced species. The amount of material available for study has been considerably greater than that used by any previous investigator and comes from a wider range of islands.

In spite of this wealth of material, there are still gaps in our knowledge. Several species are known from only one sex. Probably a few endemic species have escaped collection, and undoubtedly additional species will be introduced, intentionally or accidentally. In a few cases, such as *Pison korrorense*, the material at hand has been too limited to permit a final decision as to whether the form should be accorded specific or subspecific rank. Almost nothing is known of the habits of the species discussed. Whenever any biological facts have been recorded, even though based on extralimital observations, they have been noted in the discussion of the particular species.

I have assumed that many species were introduced into Micronesia during the war years owing to the great increase in surface and air shipping during that period. This assumption is supported by positive evidence only with respect to Guam, where there was a good deal of pre-war collecting. Swezey's (1942) list of the Guam wasps included collections through 1936. It is significant that no *Sceliphron* were taken—two species are now established

on Guam, and it is known that one of them, *lactum*, accompanied a convoy from the Solomons to Guam in 1945. These are large conspicuous insects, which could not have failed to attract attention if they had been established prior to the war. Other late-comers to Guam not taken in pre-war collections are *Tachysphex bengalensis* and *Motes laboriosus*.

Without question the outstanding collection of Micronesian aculeates, considering both the number of individuals and the number of species, was that made during the economic survey of Micronesia by the U. S. Commercial Company from May to August 1946. The entomologists of this expedition, H. K. Townes and R. G. Oakley of the Bureau of Entomology and Plant Quarantine, visited about 20 islands or island groups, and collected on all important groups in Micronesia, with the exception of the northern Marianas and the Gilbert Islands. A total of about 500 bees and wasps was obtained, and the thoroughness of the field work is attested to by the fact that nearly every species previously reported was included, as well as many others, some new and some recently introduced. The number of species represented is extraordinary considering the limited time which was available on most islands.

This material has been supplemented by several smaller lots, some collected by entomologists during their military service in the Pacific, and a post-war collection made by K. L. Maehler, of the Bureau of Entomology and Plant Quarantine. The material obtained by H. S. Dybas in 1948 in the Palaus and Ponape has not been available, but it is hoped that a study of this can be included as an appendix in Part II of the present paper.

The bees will be treated in Part II, which I hope to complete during the next year. The present section treats all families of wasps known to be present in Micronesia, with the exception of the Vespidae. This family would have been included if J. C. Bequaert had not already made a great deal of progress on his projected monograph of the Vespidae of Oceania. Since duplication of effort seemed unnecessary I have turned over to Dr. Bequaert all my material in this particular family.

Keys are presented for the ready identification of the families, genera and species at present occurring in Micronesia. Any specimen which fails to agree with the characters ascribed to a particular species, either in the keys or descriptions of new species, should be viewed with some suspicion, since it may belong to endemic or introduced species not included herein.

The synonymy listed under each species includes all references to that species based on material from Micronesia. In introduced species, the original descriptions of all synonyms, where there are any, are given also, even though these references may not have been based on material from Micronesia.

All Micronesian material listed is at present in the United States National Museum, except where specified by abbreviations in brackets following the locality data. Other collections from which

material has been examined and the abbreviations used for each such collection are as follows:

Bernice P. Bishop Museum [BPB]
Hawaiian Sugar Planters' Association [HSPA]
K. V. Krombein, personal collection [KVK]
K. L. Maehler, personal collection [KLM]

Wherever possible, duplicates of each species will be deposited in the collection of the B. P. Bishop Museum, Honolulu.

Thanks are due to F. X. Williams for valuable information on Oceanic *Pison* and the donation of several specimens from the Hawaiian Sugar Planters' Association. E. C. Zimmerman and R. H. Van Zwaluwenburg have assisted by arranging the loan of specimens from the B. P. Bishop Museum and Hawaiian Sugar Planters' Association. K. Yasumatsu has kindly sent a female paratype of his *Liris esakii*.

DISTRIBUTION OF MICRONESIAN WASPS

(An asterisk denotes an endemic or supposedly endemic species)

SCOLIIDAE

*__Campsomeris (Campsomeris) palauensis__ (Turner), Carolines (Palaus)

Campsomeris (Campsomeris) annulata (Fabricius), Marianas (Guam, Rota, Saipan)

Scolia (Scolia) ruficornis Fabricius, Carolines (Palaus)

Scolia (Triscolia) patricialis plebeja (Gribodo), Carolines (Palaus)

MUTILLIDAE

*__Timulla__ species, Carolines (Palaus)

POMPILIDAE

Auplopus species, Marianas (Guam)

Anoplius opulentus (Smith), Marianas (Guam, Tinian, Saipan), Carolines (Palaus)

*__Episyron maehleri__ sp. n., Carolines (Palaus)

VESPIDAE

The following species have been recorded from Micronesia by Bequaert and Yasumatsu, 1939 (Tenthredo **2**: 314-328, pls. 5-8), Swezey, 1942 (B. P. Bishop Mus. Bul. **172**: 186-187), Yasumatsu, 1945 (Mushi **16**: 35-45, 2 figs.), and Townes, 1946 (Rpt. **14**, U. S. Comm. Co. Surv. Micronesia, pp. 49-50), and are listed here for the sake of completeness.

Polistes olivaceus (DeGeer), Marianas (Guam, Rota, Saipan, Tinian)

*__Polistes semiflavus__ Holmgren, Marianas (Guam, Rota)

Ropalidia marginata sundaica van der Vecht, Marianas (Guam, Rota, Saipan, Tinian, Pagan), Carolines (Truk)

Rygchium haemorrhoidale var. **quinquecinctum** (Fabricius), Marianas (Guam, Rota, Saipan, Pagan)
Pachodynerus nasidens (Latreille), Marshalls (Kwajalein, Eniwetok, Majuro), Marianas (Guam), Carolines (Truk)
***Odynerus mariannensis** Bequaert and Yasumatsu, Marianas (Rota, Tinian [?])
***Odynerus paganensis** Yasumatsu, Marianas (Pagan)
***Odynerus saipanensis** Yasumatsu, Marianas (Saipan)
***Pseudonortonia esakii** Bequaert and Yasumatsu, Carolines (Palaus)
***Pseudonortonia palauensis** Bequaert and Yasumatsu, Carolines (Palaus)
***Pseudonortonia yapensis** Yasumatsu, Carolines (Yap)

SPHECIDAE

Chalybion bengalense (Dahlbom), Gilberts (Tarawa)
Sceliphron laetum (Smith), Marianas (Guam), Carolines, (Palaus)
Sceliphron madraspatanum (Fabricius), Carolines (Palaus)
Sceliphron ceamentarium (Drury), Marshalls (Kwajalein), Marianas (Guam, Saipan, Tinian)
***Lestica (Solenius) constricta** sp. n., Carolines (Palaus)
***Dasyproctus immaculatus** sp. n., Carolines (Palaus)
Tachysphex bengalensis Cameron, Marianas (Saipan), Carolines (Palaus)
Dicranorhina species, Carolines (Palaus)
Motes subtesselatus (Smith), Marshalls (Kwajalein)
Motes laboriosus (Smith), Marianas (Guam, Tinian, Saipan)
Motes manilae (Ashmead), Marianas (Guam, Saipan, Pagan), Carolines (Truk, Palaus)
***Motes townesi** sp. n., Carolines (Palaus)
Liris opulenta (Lepeletier), Marshalls (Kwajalein), Marianas (Guam, Tinian, Saipan, Pagan), Carolines (Truk, Palaus)
Liris samoensis Williams, Carolines (Ponape)
***Liris esakii** Yasumatsu, Carolines (Yap, Truk)
***Liris mindanaoensis carolinensis** Yasumatsu, Carolines (Truk)
***Liris williamsi** sp. n. Carolines (Palaus)
Solierella rohweri (Bridwell), Marshalls (Eniwetok)
Trypoxylon philippinense Ashmead, Marianas (Guam)
Pison punctifrons Shuckard, Marshalls (Enitewok), Marianas (Guam, Tinian, Saipan, Agrihan), Carolines (Kapingamarangi, Yap, Palaus)
***Pison esakii** Yasumatsu, Marianas (Guam, Rota, Tinian)
***Pison nigellum** sp. n., Carolines (Ponape)
Pison argentatum Shuckard, Marianas (Guam), Carolines (Ponape, Truk)
Pison ignavum Turner, Carolines (Palaus)
Pison hospes Smith, Marshalls (Ailinglapalap, Jaluit), Carolines (Palaus)
Pison tahitense Saussure, Marshalls (Ailinglapalap)

***Pison ponape** sp. n., Carolines (Ponape)
***Pison oakleyi** sp. n., Marianas (Guam, Rota)
Pison iridipenne Smith, Marshalls (Ailinglapalap), Marianas (Tinian), Carolines (Kusaie, Ponape, Truk, Palaus)
***Pison korrorense** Yasumatsu, Carolines (Palaus)

It is of interest to note that only the high islands have developed endemic species. The low coral atolls have only a sparse, introduced fauna derived mainly from the Oriental region. Comparatively few of the introduced species on any of the islands reached there from the east. The complete distribution of the introduced species is considered in the discussion of each such species.

KEY TO THE FAMILIES OF MICRONESIAN ACULEATES[1]

1. Pronotum reaching the tegulae, or the latter lacking entirely (a wingless female) 2
   Pronotum not reaching the tegulae, lateral surface with a rounded lobe covering spiracle 5
2. Second abdominal tergite with a narrow longitudinal band of dense appressed hairs (the "felt" line) near side; female wingless, the thorax a chitinous box, movable sutures lacking; hind wing of male without anal lobe .... **Mutillidae**
   Second tergite without such a "felt" line; females always winged, and hind wing in both sexes with an anal lobe.. 3
3. Apical third of wings lacking veins, the membrane striolate; femora and tibiae of females enlarged, fossorial, outer surface of tibiae with numerous close-set thorns .... **Scoliidae**
   Apical third of wings with veins in at least part of the area, the membrane not striolate; femora and tibiae of females not enlarged, the latter without numerous thorns 4
4. Forewing longitudinally folded when at rest; inner margin of eye deeply emarginate, the eye reniform in outline .... **Vespidae**[2]
   Forewing not longitudinally folded; inner margin of eye straight or only very slightly emarginate, not reniform in outline .... **Pompilidae**
5. None of body hairs branched or plumose, females without pollen-collecting apparatus; posterior basitarsus normally slender, not flattened nor broader than following segments .... **Sphecidae**

[1] Antennae 12-segmented in female, 13-segmented in male (12-segmented in one species, which has fore and mid tarsi strongly flattened and only one submarginal cell in forewing); abdomen with six visible segments in female, and usually seven in male.

[2] This family is not treated further in the present work.

At least some of body hairs branched or plumose, females usually with a specialized pollen-collecting apparatus, a scopa or corbiculum; posterior basitarsus usually flattened and broader than following segments.....................
..................**Colletidae, Halictidae, Megachilidae,** and **Apidae**[3]

FAMILY SCOLIIDAE

The only endemic scoliid in this area is *Campsomeris* (*Campsomeris*) *palauensis* (Turner) of the Palau Islands. Several years ago *Campsomeris* (*Campsomeris*) *annulata* (Fabricius) was liberated on Guam, Saipan and Rota Islands in the Marianas, where it is now very common and apparently an important factor in the reduction of *Anomala sulcatula* Burmeister. In 1948 two other scoliids were liberated on the Palaus for control of the rhinoceros beetle, *Oryctes rhinoceros* (Linnaeus), namely *Scolia* (*Triscolia*) *patricialis plebeja* (Gribodo) from Malaya and *Scolia* (*Scolia*) *ruficornis* Fabricius from Africa.

The four species may be separated by the following key:

1. Forewing with two complete recurrent nervures, both received by the second submarginal cell (only two submarginal cells); mesopleuron sloping gradually from beneath wing base, without a distinct dorsal surface; sexual dimorphism marked, the male very slender *Campsomeris* 2

   Forewing with only one complete recurrent nervure, this received by the second submarginal cell (two or three submarginal cells); mesopleuron with a shoulder beneath wing base having a distinct dorsal surface; sexual dimorphism not greatly developed, the male stocky *Scolia* 3

2. ♀♀: Integument entirely black, the abdominal tergites with conspicuous apical fringes of thick, pale hair; occiput, pronotum laterally, and median area of dorsal surface of propodeum with dense, conspicuous, erect white hair; wings hyaline, slightly infumated on basal two-thirds, deeply so on apical third. ♂♂: Last two abdominal segments entirely black and with black pubescence; clypeus laterally yellow, the mesopleuron and lateral surface of propodeum without pale maculations; legs black with outer surface of fore and mid femora at tip, and fore and mid tibiae entirely yellow; short, dense, decumbent pubescence of thorax silvery; Marianas ....

   Campsomeris (Campsomeris) annulata (Fabricius) (p. 374)

   ♀♀: Head between compound eye and ocelli, pronotum, and abdominal tergites one to four with yellow markings, the latter with sparse apical fringes of orange

[3] A key for these families of bees will be given in Part II of the present work.

hairs; occiput, pronotum laterally and median area of dorsal surface of propodeum with the erect hairs sparse, tinged with ferruginous; wings hyaline, uniformly infumated with yellowish. ♂ ♂: Last three abdominal segments ferruginous and with ferruginous pubescence; clypeus entirely, mesopleuron and lateral surface of propodeum extensively, yellow; legs ferruginous, much more extensively marked with yellow; short, dense, decumbent pubescence of thorax golden; Carolines (Palaus) ....
Campsomeris (Campsomeris) palauensis (Turner) (p. 373)

3. Forewing with two submarginal cells, very dark brown; dorsum of first tergite with a basal tubercle; hair of thorax and abdomen black, sparse and short; antennae orange; abdomen entirely black; Carolines (Palaus) ....**Scolia (Scolia) ruficornis** Fabricius (p. 375)

Forewing with three submarginal cells, lighter brown; dorsum of first tergite not tuberculate; hair of thorax (except mesoscutum and scutellum) and abdomen black, dense and long; antennae black; third tergite of abdomen with a pair of yellow maculations; Carolines (Palaus) ....
....**Scolia (Triscolia) patricialis plebeja** (Gribodo) (p. 375)

Campsomeris (Campsomeris) palauensis (Turner)

Scolia (*Dielis*) *palauensis* Turner, 1911. Ann. Mag. Nat. Hist. (8) 7: 308; [♀, ♂; Palaus; type in Deutsch Ent. Inst., Berlin].

Campsomeris (*Dielis*) *palauensis* (Turner) Betrem, 1928. Treubia, Suppl. vol. **9**: 92.

Campsomeris palauensis (Turner) Uchida, 1933. Jour. Faculty Agr. Hokkaido Imp. Univ. **32**: 257, pl. 2, fig. 15 [♀].—Bequaert and Yasumatsu, 1939. Tenthredo **2**: 327.—Townes, 1946. Rpt. **14**, U. S. Comm. Co. Surv. Micronesia, p. 48.

Campsomeris palauensis form *uchiyamai* Uchida, 1933. Jour. Faculty Agr. Hokkaido Imp. Univ. **32**: 257, pl. 2, fig. 14 [♂; Palaus; type in Sapporo, Hokkaido, Japan]. New synonym.

The extensive yellow maculations in both sexes and ferruginous apical segments of the male abdomen readily distinguish this sole endemic species from introduced species of Scoliidae.

Uchida's form *uchiyamai* seems to have been based on the typical male, as most specimens before me agree with his brief notes. The only respects in which Uchida's form differs from the descriptions by Turner and Betrem are that the antennae are dark brown beneath (Turner and Betrem mention only that the scape is yellow beneath—all my males have in addition the flagellum brownish beneath), and that there are two spots on the median dorsal area of the propodeum (there is variation in my specimens from those

with no markings to those with all intervening gradations of yellow markings).

I have examined the following material:

CAROLINE ISLANDS: 4 ♀ ♀, 24 ♂ ♂; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes; on roadside vegetation). 3 ♂ ♂; northeast cornor of Koror Island, Palaus; July 22, 1946 (H. K. Townes). 1 ♂; Koror Island; March 15-25, 1948 (K. L. Maehler; in forest visiting flowers). 1 ♂; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes). 3 ♀ ♀, 1 ♂; Peleliu Island; 1945 (C. K. Dorsey).

Campsomeris (Campsomeris) annulata (Fabricius)

Tiphia annulata Fabricius, 1793. Ent. syst. **2**: 225 [♀; China; type in Kiel (?)].

Campsomeris Servillii Lepeletier, 1845. Hist. nat. ins. Hym. **3**: 501 [♀; Java; type in Paris (?)].

Campsomeris (Dielis) annulata (Fabricius) Betrem, 1928. Treubia, Suppl. vol. **9**: 94, pl. 2, fig. 11 [♀, ♂; redescription and distributional notes].

Campsomeris annulata (Fabricius) Townes, 1946. Rpt. **14**, U. S. Comm. Co. Surv. Micronesia, p. 48 [common in southern Marianas].

This species has a wide distribution in Japan, Korea, China, India and the East Indies. In Korea it is parasitic on several species of *Anomala* and *Popillia* larvae. Efforts to establish it in eastern North America in 1925 and 1926 for control of *Popillia japonica* Newman were unsuccessful. It is now extremely abundant in the southern Marianas and appears to be a potent factor in reduction of the *Anomala sulcatula* population.

I have examined the following material from Micronesia:

MARIANA ISLANDS: 2 ♀ ♀, 3 ♂ ♂; Point Ritidian, Guam; June 1945 (J. L. Gressitt). 3 ♂ ♂; same data, but March 7, 1948 (K. L. Maehler; on *Ipomoea pes-caprae*). 1 ♂; Mount Santa Rosa, Guam; June 1945 (J. L. Gressitt and G. E. Bohart). 1 ♂; Yigo, Guam; March 9, 1948 (K. L. Maehler). 1 ♀, 1 ♂; Dededo, Guam; December 24, 1947 (K. L. Maehler). 1 ♀, 1 ♂; Point Oca, Guam; May 1945 (J. L. Gressitt and G. E. Bohart). 1 ♂; same data, but December 20, 1945 (J. L. Gressitt; at light). 1 ♂; Ukudu, Guam; January 3, 1945 (J. L. Gressitt and G. E. Bohart). 1 ♀; Haputo Point, Guam; March 14, 1948 (K. L. Maehler). 1 ♂; Agaña, Guam; May 23, 1945 (J. L. Gressitt and G. E. Bohart). 1 ♂; same data, but August 4, 1945 (J. L. Gressitt). 1 ♀; same data, but January 30, 1948 (K. L. Maehler; on *Ipomoea*). 1 ♀, 6 ♂ ♂; Mount Alutom, Guam; June 6, 1946 (H. K. Townes). 7 ♂ ♂; same data, but June 18, 1946 (H. K. Townes). 2 ♂ ♂; Rota, Rota; June 20, 1946 (H. K. Townes; beginning to roost gregariously on *Casuarina equisetifolia* at sundown). 1 ♂; same data, but June 23,

1946 (H. K. Townes). 6 ♂ ♂ ; Oscilita, Rota; June 27, 1946 (R. G. Oakley). 1 ♂ ; native settlement, Saipan; June 18, 1946 (R. G. Oakley). 1 ♂ ; Susupe, Saipan; January 2, 1948 (K. L. Maehler). 1 ♂ ; Hagoya Lake, Tinian; June 10, 1946 (H. K. Townes).

Scolia (Scolia) ruficornis Fabricius

Scolia ruficornis Fabricius, 1793. Ent. syst. **2**: 230 [♂ ; Senegal; type in Paris (?)].

About 150 specimens of this African species were liberated in the Palaus in 1948 for control of *Oryctes rhinoceros* (Linnaeus). No reports have been received yet as to whether the species has become established.

I have included it in the key on the basis of specimens from Africa.

Scolia (Triscolia) patricialis plebeja (Gribodo)

Triscolia patricialis var. *plebeja* Gribodo, 1893. Bul. Soc. Ent. Ital. **25**: 168 [♀ , ♂ ; Borneo, Malacca; type in Genoa].

Scolia (Triscolia) patricialis plebeja (Gribodo) Betrem, 1928. Treubia, Suppl. vol. **9**: 235.

About 100 specimens of this wasp collected by T. R. Gardner in Malaya were liberated in the Palaus in 1948 for the control of *Oryctes rhinoceros*. Recently D. B. Langford, Staff Entomologist of the Trust Territory, wrote C. P. Clausen, of the Bureau of Entomology and Plant Quarantine, that he had seen specimens of this wasp in the field several months after liberations, an indication that the species is becoming established.

I have not examined specimens of the atypical subspecies *plebeja*, but have seen two females of the typical subspecies from North Borneo. These females have the head above antennae, scutellum, postscutellum, median dorsal surface of propodeum, median spot on dorsum of first abdominal tergite, and basal band on third tergite, orange. These specimens agree with Betrem's interpretation of *patricialis patricialis*. Betrem separates *patricialis plebeja* by the reduction or total absence of yellow markings on the thorax and first abdominal tergite.

FAMILY MUTILLIDAE

Esaki, 1938 (Annot. Zool. Jap. **17**: 431-2, fig.) records a female of the New Guinea *Timulla (Trogaspidia) albertisi* (André) from Ashiasu, Peleliu, Palau Islands. I view this determination with a great deal of suspicion, especially since Esaki states (italics mine), "My specimen agrees very well with the description of André (1896), *except for some details of the pubescence.*" Females in this genus are very difficult to determine, and separation depends in many cases on seemingly minute differences in the pubescence. Unfortunately Esaki does not mention what these differences are. Even though the wingless females in this genus are frequently carried in flight by the males during mating, I regard it as extremely

unlikely that the New Guinea species could become established in the Palaus in this way. In all probability the Palau form represents a discrete new species, but lacking material I am unable to carry the matter any further. Esaki has assigned the species to the correct genus, as his photograph is unmistakably that of a *Timulla*.

The female may be readily recognized by being wingless, about 10 mm. long, black with a pair of oval spots on the second abdominal tergite and a broad transverse band on the third tergite, both of pale, appressed pubescence. The male is unknown, but males of this genus are winged, have reniform compound eyes, large tegulae, and a sessile first abdominal segment.

FAMILY POMPILIDAE

These wasps, popularly known as spider wasps from their habit of provisioning the cells for the young with paralyzed spiders, are poorly represented in Micronesia. Apparently the only endemic species is the new *Episyron* from the Palaus described below. In addition, there is the oceanic vagrant, *Anoplius opulentus* (Smith), which became established during and after the war in the Marianas and Palaus, and an *Auplopus* (*olim Pseudagenia*) probably introduced on Guam (my single specimen is in too poor condition for specific identification).

The three specimens before me may be separated by the following key:

1. Subdiscoidal vein of forewing meeting discoidal vein at a right angle so that third discoidal cell does not have a pocket at base. ♀♀: Second abdominal sternite with a deep transverse groove before middle; pygidium a flattened, oval, shining or shagreened area. ♂♂: First abdominal segment very slender and elongate, in length somewhat over four times the width at base; Marianas (Guam)..**Auplopus** species (p. 377)

   Subdiscoidal vein of forewing abruptly angulate at base and meeting discoidal vein at an acute angle so that the third discoidal cell has a distinct pocket at base. ♀♀: Second abdominal sternite without a transverse groove; pygidial area not delimited, the last tergite uniformly convex and clothed with erect bristles. ♂♂: First abdominal segment much broader, its length not over three times the width at base 2

2. Pale integumental maculations lacking except on seventh tergite of male, the entire body strikingly ornamented with numerous spots of appressed silvery pubescence, none of pubescence consisting of modified scale-like setae; wings dusky, the tips darker; apical margin of clypeus subtruncate on middle two-thirds, mandibles not hidden by clypeus when head is viewed from in front. ♀♀: Tarsal claws not cleft, but with a small erect tooth at middle. ♂♂: Fourth abdominal sternite slightly con-

cave, covered with dense, suberect hairs having kinky tips; hypopygium tectiform; Marianas, Carolines (Palaus).................................**Anoplius opulentus** (Smith) (p. 377)

Clypeus, face, occiput, pronotum, hind tibia and second and third abdominal tergites with ivory integumental maculations; some pubescence on pronotum, postscutellum, propodeum, first abdominal segment (and base of second also in male) dense, appressed and scale-like; wings clear hyaline, tips dusky; apical margin of clypeus broadly rounded, mandibles almost completely hidden by clypeus when head is viewed from in front. ♀♀: Tarsal claws cleft. ♂♂: Fourth abdominal sternite convex, without differentiated hairs; hypopygium slightly convex; Carolines (Palaus).................................
.................................**Episyron maehleri,** new species (p. 378)

Auplopus species

I place here a single male from Point Oca, Guam; May 1945 (G. E. Bohart and J. L. Gressitt). The specimen is in deplorable condition, apparently having been mashed between the cork and lip of the collecting bottle, since the head is broken and most of the antennae and legs are missing. It is, however, recognizable as an *Auplopus* (*olim Pseudagenia*), because of the slender first abdominal segment and lack of a pocket at the base of the third discoidal cell of the forewing. I suppose it is an introduced species, as it was not taken on any of the earlier Guam surveys, but I am unable to match it with any of the available Philippine or North American species in the National Museum collection. However, males of only a few of the Philippine species are known.

Anoplius opulentus (Smith), new combination

Pompilus opulentus Smith, 1860. Jour. Proc. Linn. Soc. London, Zool. **5**: 120 [♀; Batjan Island, Moluccas; type in Oxford]. —Dalla Torre, 1897. Cat. Hym. **8**: 308.

Pompilus elatus Smith, 1865. Jour. Proc. Linn. Soc. London Zool. **8**: 82 [♀; Morotai Island, Moluccas; type in Oxford]. —Dalla Torre, 1897. Cat. Hym. **8**: 286.—Williams, 1945. Proc. Hawaii. Ent. Soc. **12**: 436-7, fig. 11 [♀, ♂; descriptive notes; various localities in New Caledonia].—Williams, 1947. Occas. Papers B. P. Bishop Mus. **18**: 326 [quotes Turner's Fiji record]. New synonymy.

Pompilus manokwariensis Cameron, 1906. Res. Exped. Neerl. Nov. Guin. **5**: 55 [♀; Manokwari, Dutch New Guinea; type in Amsterdam]. New synonymy.

Pompilus inquirendus Vachal, 1907. Rev. d'Ent. **26**: 117 [♀, ♂; New Caledonia; type in Paris]. New synonymy.

Psammochares elatus (Smith) Turner, 1917. Trans. Roy. Ent. Soc. London, 1917, p. 73 [records from Mackay and Townsville, Queensland, Australia].—Turner, 1919. Trans. Roy.

Ent. Soc. London, 1918, p. 340 [records from Fiji and New Caledonia; also synonymizes **inquirendus** Vachal].

Anoplinellus minor Banks, 1941. Occas. Papers B. P. Bishop Mus. **16**: 243, fig. 1 h [♀, ♂ ; Fulakora (?) and Auki, Malaita Island, Solomons; type in Honolulu]. New synonymy.

Pompilinus (?) sp., Williams, 1945. Proc. Hawaii. Ent. Soc. **12**: 425 [♂ ; Saipan].

Psammocharidae sp. Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [Palaus and Marianas].

Apparently the nesting habits of this wasp are such that it has been readily transported by commerce in the past, and with the advent of air travel the adults themselves are probably being transferred to new localities. It seems likely that this species came originally from the East Indies and reached by successive steps New Guinea, Australia and the Solomon Islands. The colonies in the Palaus and Marianas reported below seem to have been established by air transport during the war, in part at least, for H. K. Townes informs me that specimens were found most commonly in the vicinity of airfields.

The new synonymy listed above is based almost entirely on the original descriptions. The pattern of silvery pubescence is quite striking, and is mentioned by each of the authors. At my request H. K. Townes kindly made notes on the male allotype of *Anoplinellus minor* Banks at the Museum of Comparative Zoology at Harvard College which further confirmed my suspicion as to the identity of that species.

I have seen specimens from New Caledonia, New Guinea and the Solomons, in addition to those from Micronesia listed below:

MARIANA ISLANDS: 1 ♀ ; Mt. Lasso, Tinian; June 9, 1946 (H. K. Townes). 1 ♀ ; Tinian; June 11, 1946 (R. G. Oakley). 1 ♂ ; Charan Kanoa, Saipan; August 20, 1944 (D. G. Hall). 1 ♂ ; U. S. Commercial Co. farm, Saipan; June 17, 1946 (R. G. Oakley). 1 ♀ ; Susupe, Saipan; January 1, 1948 (K. L. Maehler). 1 ♀ ; Agaña airport, Guam; May 23, 1948 (K. L. Maehler).

CAROLINE ISLANDS: 2 ♀ ♀, 2 ♂ ♂ ; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes).

Episyron maehleri,[4] new species

Psammocharidae sp. Townes, 1946. Rept. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [Palaus].

The present species seems closest to the Bombay, India, *decoratus* (Smith), and may be identical with the female recorded as *decoratus* from Formosa by Yasumatsu, 1937 (Mushi **10**: 72). Females of both species agree in being more or less shining, and in having the clypeus broadly rounded apically and the short

[4] For K. L. Maehler, Division of Foreign Plant Quarantine, Bureau of Entomology and Plant Quarantine, whose collections in Micronesia have added much to the completeness of the present paper.

tarsal comb. However, they differ in several details of coloration which seem of specific importance. Thus, *decoratus* is essentially a more extensively maculated species, having ivory maculations along the inner and outer eye margins, posterior margin of pronotum, posteriorly on the mesoscutum, on the mesopleuron below the wing base, at base of hind tibia, a pair of lateral spots on the second and third abdominal tergites, and a fascia at the base of the fifth tergite, but the clypeus is entirely black; *maehleri* is much less extensively maculated with ivory, lacking spots on the mesoscutum, mesopleuron and fifth tergite; but the third tergite has a broad fascia instead of lateral spots, and the clypeus is entirely pale except for the narrow apical margin and a quadrate mark at the base. The scutellum in *maehleri* is very prominently gibbose and the interocellar area is flat; these characters are not mentioned in the descriptions of *decoratus*. *E. maehleri* is distinguished from any of the known Philippine species by the combination of characters listed above.

Type: ♀; northeast corner of Koror Island, Palaus; July 22, 1946 (H. K. Townes; in native forest on rough limestone rocks). [U. S. National Museum, Type No. 59034.]

Female—Length 9 mm. (apical abdominal segments somewhat telescoped), forewing 9 mm. Black, shining, with dark blue reflections in certain lights; mandible ferruginous near tip; clypeus except narrow apical margin and quadrate basal mark, a band (broader below) along inner eye margin from base of clypeus to a point opposite anterior ocellus, narrower band along outer eye margin, band on pronotum extending from tubercles, narrowed toward middle and slightly interrupted there, small spot near base of hind tibia externally, rounded anterolateral spot on second tergite emarginate behind, and broad fascia at base of third tergite emarginate at middle of posterior margin, ivory. Wings hyaline, iridescent, tip of forewing infumated, veins fuscous. Body rather evenly covered with short, moderately dense sericeous pubescence having slight silvery reflections in certain lights; the head, thorax, coxae beneath, and abdomen with short, erect dark hairs, denser on head and fore coxae than on thorax, extremely sparse on abdomen; in addition, the pronotum, side of scutellum, postscutellum, propodeum and first abdominal tergite with appressed, short scales having silvery to pale greenish blue reflections, dense on first tergite, more scattered elsewhere.

Head in anterior aspect subcircular, flattened across the top, its greatest width 1.14 times the height from apical margin of clypeus to top of head; mandibles almost entirely covered by the large clypeus; apical margin of clypeus very broadly rounded, not reflexed nor impunctate, its length in middle half the greatest width; eyes strongly convergent posteriorly, the interocular distance at hind ocelli narrow, equal to the length of the second flagellar segment and only 0.54 times the interocular distance at base of clypeus; interocellar area flat, the ocelli in a low triangle, the postocellar distance 1.7 times the ocellocular distance; antennae long and slender, the scape, pedicel and first two flagellar segments in a ratio of about 3:1:5:3.

Pronotum evenly and shallowly arcuate posteriorly; scutellum strongly gibbose, flattened anteriorly in the middle, the sides and posterior abruptly declivous.

Anterior coxa and trochanter together as long as mesopleuron; anterior tarsus with a comb of short spines, the basitarsus with three spines, none of them longer than second tarsal segment; pulvillar comb consisting of about nine moderately long, subparallel setae.

Forewing with third submarginal cell strongly narrowed above, its width

on radial vein half its width on cubital, basal and transverse median veins interstitial; cubitus in hind wing interstitial with transverse median vein.

Allotype: ♂; Koror Island, Palaus; March 15-25, 1948; (K. L. Maehler). [U. S. National Museum.]

Male—Length 7 mm., forewing 6 mm. Coloration and pubescence as in female with the following exceptions: Clypeus black, hind tibia ivory on basal half externally and ferruginous beneath, anterolateral ivory spot on second tergite very much reduced in size, fascia on third tergite broadly interrupted in middle, second tergite with some scattered, short appressed scales.

Head in frontal view tending toward subcordate, flattened above, its greatest width 1.16 times the height from apex of clypeus to top of head, mandibles almost completely covered by the large clypeus; apical margin of clypeus rounded, though tending toward subtruncate on median two-thirds, not reflexed, the length in middle half the greatest width; eyes not so strongly convergent above as in female, the interocular distance across narrowest part of vertex 0.88 times the interocular distance at base of clypeus and over twice the length of the second flagellar segment; ocelli in a low triangle, the interocellar area flat, the postocellar distance 0.8 times the ocellocular distance; antennae shorter and stouter than in female, the scape, pedicel and first two flagellar segments in a ratio of about 3:1:3:3.

Thorax much as in female, the scutellum not quite so prominently gibbose.

Hypopygium slightly convex, the apex broadly rounded.

FAMILY SPHECIDAE

Key to the Micronesian Species

1. Forewing with one or three submarginal cells, if with three, the second never petiolate above; inner margin of compound eye not deeply emarginate except in *Trypoxylon philippinense* which has only one submarginal cell 2

   Forewing with three submarginal cells, the second petiolate above; inner margin of compound eye deeply emarginate except in *Solierella rohweri* 18

2. Abdomen basally with a long, slender petiole composed of first sternite only, the first tergite a small cap at apex of segment, the petiole longer than remainder of abdomen; large, slender, metallic blue or black and yellow forms, 15 mm. or more in length 3

   Abdomen usually sessile, if petiolate (*Trypoxylon philippinense, Dasyproctus immaculatus* and *Dicranorhinus* sp.) the petiole consisting of both tergite and sternite and not as long as rest of abdomen; smaller species, not metallic blue, entirely without yellow maculations except in *Lestica constricta*, not over 10 mm. in length.... 6

3. Apical margin of clypeus tridentate in middle; dorsum of propodeum not set off from lateral and posterior surfaces by a U-shaped groove; metallic blue; Gilberts (Tarawa) .... **Chalybion bengalense** (Dahlbom) (p. 386)

   Apical margin of clypeus truncate in middle or with a narrow central emargination dividing the middle section into two rounded lobes; dorsum of propodeum set off from lateral and posterior surfaces by a deep U-shaped groove; black and yellow forms. *Sceliphron* 4

4. Viewed from above the hind coxa rectangulate at base on outer margin; side of propodeum impunctate between the oblique rugae; female with apex of fourth abdominal tergite and last two segments entirely, male with apices of fourth and fifth, and sixth and seventh tergites entirely, yellow; Marianas, Carolines (Palaus)..**Sceliphron laetum** (Smith) (p. 386)

   Viewed from above the hind coxa rounded at base on outer margin; side of propodeum punctate between the oblique rugae; apex of abdomen entirely black.............. 5

5. Sides of thorax dull; erect hair of head and thorax dark brown except on yellow maculations; hind trochanter and femur, and petiole of abdomen black; first tergite usually yellow in part; Marshalls, Marianas...**Sceliphron caementarium** (Drury) (p. 388)

   Sides of thorax shining; erect hair of head and thorax pale; hind trochanter, basal half of hind femur and abdominal petiole, yellow; first tergite entirely black; Carolines (Palaus)....**Sceliphron madraspatanum** (Fabricius) (p. 387)

6. Forewing with one submarginal cell; hind ocelli normal, circular, convex 7

   Forewing with three submarginal cells; hind ocelli distorted, flattened, subovate 9

7. Inner margin of compound eye deeply emarginate; elongate slender form with petiole of first abdominal segment slightly longer than hind tibia; abdomen red and black; Marianas (Guam) ....**Trypoxylon philippinense** Ashmead (p. 400)

   Inner margin of compound eye straight; short, stocky forms with first segment of abdomen sessile or subpetiolate; abdomen immaculate or black and yellow................ 8

8. Dull, mat, nearly impunctate, immaculate form with first segment of abdomen subpetiolate (more strongly so in male) and somewhat nodose at apex, the other abdominal segments not noticeably constricted at base and apex; antennal scape bicarinate beneath; legs of male not modified; Carolines (Palaus)..**Dasyproctus immaculatus**, new species (p. 392)

   Shining, coarsely and closely punctate form with abundant yellow maculations, the first abdominal segment sessile, not nodose at apex, the second to fifth segments noticeably constricted at base and apex; antennal scape ecarinate beneath (male) or weakly unicarinate (female); legs of male greatly modified, the fore femur flattened beneath and densely hairy, the fore and mid tarsi strongly flattened; Carolines (Palaus).................................**Lestica (Solenius) constricta,** new species (p. 389)

9. Front along margin of eye not swollen; posterior ocelli oblique in position; pronotum with a distinctly dorsal

posterior surface, the mesoscutum not overhanging the pronotum; Marianas, Carolines (Palaus)..**Tachysphex bengalensis** Cameron (p. 393)

Front along margin of eye with a longitudinal swelling; posterior ocelli transverse in position; pronotum without a distinct dorsal surface posteriorly, more or less overhung by the mesoscutum.. 10

10. Mandible with a conspicuous tooth beneath near base...... 11

Mandible not toothed beneath near base. *Liris*[5].................. 15

11. First abdominal segment petiolate, the apex much narrower than the width of the second segment; top of head flattened, the anterior ocellus not in a depression; Carolines (Palaus)............................**Dicranorhina** species (p. 394)

First abdominal segment sessile apically, not narrower than the base of the second segment; top of head with a broad depressed area around the anterior ocellus. *Motes* 12

12. Entire body dull through excessively fine, dense punctation, the individual punctures on thorax not resolvable under 48 diameters magnification; dorsum of propodeum either very faintly or not at all rugosoreticulate; hind femur in male excavate beneath near base....................................... 13

Body shining, the punctures larger and resolvable at as low as 10 diameters magnification; dorsum of propodeum coarsely rugosoreticulate; hind femur of male rounded beneath 14

13. Side of propodeum with oblique rugae developed to some extent. ♀♀: Wings not infumated with yellow; apical third of clypeus shining and practically impunctate. ♂♂: Concave part of under surface of fore femur with short, dense, appressed silvery hairs; apical margin of clypeus rounded outwardly in middle; Marshalls...**Motes subtesselatus** (Smith) (p. 394)

Side of propodeum not at all rugose. ♀♀: Wings strongly infumated with yellow; clypeus punctate almost to apical margin, with only a very narrow, shining, impunctate rim. ♂♂: Concave part of under surface of fore femur with dense, longer, suberect silvery hairs; apical margin of clypeus subtruncate in middle; Marianas...**Motes laboriosus** (Smith) (p. 394)

14. Thoracic punctation relatively dense, most of those on mesopleuron separated by not more than the diameter of a puncture. ♀♀: Pygidial punctation contiguous, interspaces not noticeable. ♂♂: Paramere of genitalia abruptly narrowed at middle, the apical half more slender; Marianas, Carolines..**Motes manilae** (Ashmead) (p. 395)

Thoracic punctation comparatively much sparser and

[5] *Liris mindanaoensis carolinensis* Yasumatsu is not included in this key. See discussion of this species below.

finer, most of those on mesopleuron separated by several times the diameter of a puncture. ♀♀: Pygidial punctation sparser, the interspaces noticeable. ♂♂: Paramere more gradually narrowed, the apical half not as slender as in above species; Carolines (Palaus) ....**Motes townesi,** new species (p. 396)

15. Head with a short horizontal section behind eyes; head and thorax with abundant, appressed golden pubescence; antennal scape, tegula and legs except coxae and trochanters, ferruginous; anterior tibia with a row of spines above; Marshalls, Marianas, Carolines................................ ....**Liris opulenta** (Lepeletier) (p. 397)

Head abruptly declivous behind top of eyes; head and thorax with the pubescence sparse, silvery, and usually suberect; entirely black; anterior tibia not spinose above...... 16

16. Dorsum of propodeum with stronger carinae curving outwardly; mesoscutal punctation sparser posteriorly, most of punctures there separated by more than the width of a puncture; wings strongly infumated with brown and with violaceous reflections; pygidial pile of female dark brown; male with carinae on lateral surface of propodeum practically absent; Carolines (Truk, Yap)............ ....**Liris esakii** Yasumatsu (p. 397)

Dorsum of propodeum with much weaker, oblique carinae; mesoscutal punctation denser posteriorly than in *esakii,* most of the punctures separated by distinctly less than the width of a puncture; wings either hyaline with the extreme tips darker (*williamsi*), or infumated (*samoensis*) though less strongly so than in *esakii*.................................. 17

17. Wings clear hyaline, the extreme tips slightly darkened, and with iridescent reflections; posterior surface of propodeum dull, scabrous; pygidial pile of female dark brown; male unknown; Carolines (Palaus).................... ....**Liris williamsi,** new species (p. 398)

Wings moderately infumated with yellowish brown, and with violaceous reflections; posterior surface of propodeum shining, not scabrous; pygidial pile of female pale golden; male with well-developed carinae on part of lateral surface of propodeum; Carolines (Ponape)........ ....**Liris samoensis** Williams (p. 398)

18. Inner margin of compound eye straight; marginal cell truncate at apex; size small, not over 4.5 mm. long; Marshalls....................**Solierella rohweri** (Bridwell) (p. 399)

Inner margin of compound eye deeply emarginate in middle; marginal cell acute at apex; size larger, rarely less than 5.5 mm. long. *Pison*.. 19

19. Front with large contiguous punctures; thorax with rather dense, large punctures, the interspaces shining; dorsal surface of propodeum with strong, oblique carinae;

hypopygium of male broadly and deeply emarginate at apex, the lateral arms long and slender; Marshalls, Marianas, Carolines......**Pison punctifrons** Shuckard (p. 400)

Front and thorax with smaller, usually more scattered punctures, the interspaces on thorax usually dull, shining in only a few species; dorsal surface of propodeum smooth and sparsely to rather densely punctate, or if obliquely carinate, the carinae very fine; hypopygium of male truncate or with a very shallow emargination at apex; the lateral arms very short.......... 20

20. Head and thorax with the erect pubescence dense and black 21

Head and thorax with the erect pubescence either entirely lacking or dense but when present always silvery except brownish on mesoscutum in *ponape*.......... 22

21. Lateral surface of propodeum separated from dorsal and posterior surfaces by a strong carina extending from the spiracle almost to the apex; median carina on dorsal surface of propodeum strong, complete, and contained in a moderately deep sulcus; clypeal lobe semicircular in outline; wings infuscated with dark brown and with violaceous reflections; larger, ♀ 9-11 mm. long; Marianas..........**Pison esakii** Yasumatsu (p. 401)

No such carina separating the lateral from dorsal and posterior surfaces of propodeum; median carina on dorsal surface of propodeum very weak, evanescent posteriorly, and contained in a very weak, shallow sulcus; clypeal lobe more or less pentagonal in outline; wings hyaline and with iridescent reflections; smaller, ♀ 8 mm., ♂ 7.2 mm. long; Carolines (Ponape).......... ....**Pison nigellum,** new species (p. 401)

22. Decumbent silvery pubescence on clypeus so dense that it obscures the punctation; second recurrent vein of forewing received in middle of second submarginal cell; tibial calcaria pale.......... 23

Clypeal pubescence sparser, not obscuring the punctation; second recurrent vein of forewing interstitial with second transverse cubital vein or received in third submarginal cell near base; tibial calcaria black.......... 24

23. Smaller forms, average length of ♀ 6.0 mm., of ♂ 5.0 mm.; oblique carinae on dorsum of propodeum weaker, usually evanescent toward margins; apical margin of clypeal lobe of female not depressed in middle; punctation finer, though equally as dense; Marianas (Guam), Carolines (Ponape, Truk).......... ....**Pison argentatum** Shuckard (p. 403)

Larger forms, average length of ♀ 8.0 mm., of ♂ 7.0 mm.; oblique carinae on dorsum of propodeum stronger, usually complete to margins; clypeal lobe of female

depressed in middle of apical margin giving it a bilobed appearance; punctation coarser; Carolines (Palaus).... ....**Pison ignavum** Turner (p. 404)

24. Mesopleuron with large, coarse, subcontiguous punctures, the interspaces shining; third sternite of male not tuberculate or ridged; ocellocular distance in female at least half the postocellar distance; larger, ♀ usually over 9 mm., ♂ over 8 mm. in length.. 25

Mesopleuron with smaller punctures separated by at least the width of a puncture, the interspaces dull from shagreening except in *oakleyi*; third sternite of male tuberculate or ridged; ocellocular distance in female much less than half the postocellar distance; smaller, ♀ not over 8 mm., ♂ not over 7 mm. in length.................................. 27

25. Clypeal lobe triangular; second sternite densely punctate, the punctures separated by not much more than the diameter of a puncture; Marshalls, Carolines (Palaus) ....**Pison hospes** Smith (p. 404)

Clypeal lobe rounded or more or less pentagonal in outline; second abdominal sternite more sparsely punctate, the punctures separated by several times the diameter of a puncture.. 26

26. Dorsum of propodeum with median carina well-defined on at least the basal half, the median sulcus more or less evanescent on anterior half, but present posteriorly; posterior surface of propodeum finely, transversely rugulosopunctate; wings moderately infumated with brown and with faint violaceous reflections; Marshalls ....**Pison tahitense** Saussure (p. 405)

Dorsum of propodeum without a median carina, but the median sulcus deeper on entire length of surface; posterior surface of propodeum on lower half with about four strong transverse rugae, not punctate; wings clear hyaline and with iridescent reflections; male unknown; Carolines (Ponape).. ....**Pison ponape,** new species (p. 405)

27. Mesopleuron shining, the impunctate interspaces not delicately shagreened; wings rather strongly infumated with dark brown and with violaceous reflections; third sternite of male with a small, low, rounded tubercle near middle; Marianas....**Pison oakleyi,** new species (p. 406)

Mesopleuron opaque, the impunctate interspaces delicately shagreened; wings not infumated with brownish, the reflections iridescent; third sternite of male either with a short transverse ridge or a pair of mammilate tubercles in middle.. 28

28. Front finely granulate and with superimposed shallow punctures, the interspaces broader and not forming a network of fine carinae; third sternite of male with a

short transverse ridge in middle; Marshalls, Marianas, Carolines (Ponape, Truk, Palaus)..**Pison iridipenne** Smith (p. 408)

Front with deeper, closer punctures, the interspaces very narrow and forming a network of fine carinae; third sternite of male with a pair of mammilate tubercles in middle; Carolines (Palaus)...**Pison korrorense** Yasumatsu (p. 409)

Chalybion bengalense (Dahlbom)

Pelopoeus violaceus Lepeletier and Serville, 1825. Encycl. meth. Ins. **10**: 35 [♀ ; East Indies; misidentification of *Sphex violacea* Fabricius, 1775].

Pelopoeus (*Chalybion*) *Bengalensis* Dahlbom, 1845. Hym. Europ. **1**: 433 [Bengal; type in Lund, Sweden].

Sceliphron (*Chalybion*) *bengalense* (Dahlbom) Kohl, 1918. Ann. Naturhist. Hofmus. Wien **32**: 54 [♀ , ♂ ; redescription in revision; records from Ethiopian, Oriental and Australian regions].

This species has a wide distribution in the Palaearctic, Ethiopian, Oriental and Australian regions, and has become established just recently in Hawaii (Weber, 1948. Proc. Hawaii. Ent. Soc. **13**: 205; first captured in Hawaii in 1947). D. G. Hall informs me that he found the species to be relatively common on Tarawa in the Gilbert Islands in 1945, so perhaps the first migrants to Hawaii came from that particular population. Presumably the species was established on Tarawa during the Japanese occupation either from Japan or the Philippines.

Horne, 1870 (Trans. Zool. Soc. London **7**: 163-4, pl. 21, figs. 2, 2a), notes that this species in India constructs one or more clay cells which are provisioned with small spiders.

GILBERT ISLANDS: 1 ♀, 3 ♂ ♂ ; Tarawa Island; July 23, 1945 (D. G. Hall) [KVK].

Sceliphron laetum (Smith)

Pelopoeus laetus Smith, 1856. Cat. Hym. Brit. Mus. **4**: 229, pl. 7, fig. 1 [♀ , ♂ ; Australia, Ceram; type in London].

Sceliphron (*Pelopoeus*) *laetum* (Smith) Kohl, 1918. Ann. Naturhist, Hofmus. Wien **32**: 95, figs. 24, 49 [♀ , ♂ ; redescription in revision; records from Moluccas, New Guinea, New Britain, Australia and New Zealand].

Sceliphron sp. Townes, 1946. Rpt. **14**, U. S. Comm. Co. Surv. Micronesia, p. 50 [common in the Palaus].

This species is readily distinguished from all known species of the genus by the combination of the hind coxa being rectangulate at the base on the outer margin and the apical segments of the abdomen being yellow.

The colonies on Guam and the Palaus almost certainly were

established during the war years by military traffic from the Solomons, and perhaps New Guinea. Several years ago G. E. Bohart informed me that specimens of this species accompanied the ship on which he sailed from the Solomons to Guam early in 1945.

This and the following two species build clay cells which they provision with small spiders.

I have seen material from Australia, New Guinea and the Solomons in addition to that listed below from Micronesia:

MARIANA ISLANDS: 1 ♂ ; Inarajan, Guam; March 6, 1948 (K. L. Maehler).

CAROLINE ISLANDS: 5 ♀ ♀ , 12 ♂ ♂ ; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes). 6 ♀ ♀ , 1 ♂ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler).

Sceliphron madraspatanum (Fabricius)

Sphex madraspatana Fabricius, 1781. Spec. ins. **1**: 445 [Malabar; type in London (?)].

Pelopoeus interruptus Palisot de Beauvois, 1805. Ins. rec. Afr. Amer., Hym., p. 50, pl. 7, fig. 5 [type in London (?)].

Pelopaeus bilineatus Smith, 1852. Ann. Mag. Nat. Hist. (2) **9**: 47 [♀ ; Bombay, India; type in London].

Pelopaeus separatus Smith, 1852. Ann. Mag. Nat. Hist. (2) **9**: 47 [♀ ; Bombay, India; type in London].

Pelopoeus pictus Smith, 1856. Cat. Hym. Brit. Mus. **4**: 231 [♂ ; India; type in Oxford (?)].

Pelopoeus conspicillatus A. Costa, 1864. Ann. Mus. Zool. Napoli **2**: 112 [♀ , ♂ ; Luzon, Philippines; type in Naples].

Sceliphron (Pelopoeus) kohli Sickmann, 1894. Zool. Jahrb., Abt. f. Syst. **8**: 218 [♀ , ♂ ; Tientsin, China; type in Münster (?)].

Sceliphron (Pelopoeus) madraspatanum (Fabricius) Kohl, 1918. Ann. Naturhist. Hofmus. Wien **32**: 109 [♀ , ♂ ; redescription in revision; records from India, Ceylon, Assam, Burma, Malaya, Sumatra, Java, Borneo, Philippines and Formosa].

Sceliphron sp. Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [common in the Palaus].

This and the following species belong in the group having the hind coxa rounded at base on outer margin as contrasted with the group exemplified by the preceding species in which this coxa is rectangulate at base on outer margin. Although *madraspatanum* is closely related to *caementarium*, the two are easily separated by the characters noted in the key.

I assume this species was introduced recently to the Palaus from the Philippines, for Yasumatsu does not record it from pre-war material from the Palaus.

CAROLINE ISLANDS: 1 ♀ , 7 ♂ ♂ ; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes). 1 ♀ ; Gapik, Babelthuap Island, Palaus; July 19, 1946 (R. G. Oakley). 1 ♀ ; Babelthuap

Island; July 26, 1946 (H. K. Townes). 2 ♂ ♂ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler).

Sceliphron caementarium (Drury)

Sphex caementaria Drury, 1770. Illustr. Nat. Hist. **1**: 105, pl. 44, figs. 6-8; pl. 45, figs. 8, 10 [♀ , ♂ ; West Indies].

Sphex flavomaculata DeGeer, 1773. Mem. hist. Ins. **3**: 588, pl. 30, fig. 4 [♀ ; Pennsylvania; type in Stockholm].

Sphex lunata Fabricius, 1775. Syst. ent., p. 347 [Antigua; type in Kiel (?)].

Sphex flavipes Fabricius, 1781. Spec. Ins. **1**: 444 [America; type in Kiel (?)].

Sphex flavipunctata Christ, 1791. Naturges. Ins., p. 301, pl. 30, fig. 1 [West Indies; apparently proposed for *caementaria* Drury].

Sphex affinis Fabricius, 1793. Ent. syst. **2**: 203 [West Indies; type in Kiel (?)].

Pelopoeus architectus Lepeletier, 1845. Hist. nat. ins. Hym. **3**: 313 [♀ ; New Orleans; type in Turin (?)].

Pelopoeus Servillei Lepeletier, 1845. Hist. nat. ins. Hym. **3**: 313 [♀ ; type locality unknown; type in Paris].

Pelopoeus Solieri Lepeletier, 1845. Hist. nat. ins. Hym. **3**: 318 [♀ ; Guadaloupe; type in Paris].

Pelopoeus Canadensis Smith, 1856. Cat. Hym. Brit. Mus. **4**: 233 [♂ ; Canada; type in London].

Pelopoeus nigriventris A. Costa, 1864. Ann. Mus. Zool. Napoli **2**: 60 [North America; type in Naples].

Pelopoeus tahitensis Saussure, 1867. Reise d. Novara, Zool. **2**: 27, pl. 2, fig. 17 [♀ , ♂ ; Tahiti; type in Geneva].

Sceliphron (Pelopoeus) caementarium (Drury) Kohl, 1918. Ann. Naturhist. Hofmus. Wien **32**: 115, figs. 4, 58 [♀ , ♂ ; redescription in revision; records from North and Central America, West Indies and Tahiti].

Sceliphron caementarium (Drury) Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [common on Tinian and Saipan].

This New World species has been established in Hawaii and Tahiti for a number of years, and it is likely that the colonies in the Marshalls and Marianas were established from specimens from Hawaii during the war.

MARSHALL ISLANDS: 3 ♀ ♀ , 4 ♂ ♂ ; airport on Kwajalein Island; November 4, 1946.

MARIANA ISLANDS: 1 ♂ ; Afetna Point, Saipan; June 27, 1946 (H. K. Townes). 1 ♀ , 4 ♂ ♂ ; Tinian; June 8, 1946 (H. K. Townes). 1 ♀ ; central section of Tinian; December 31, 1947 (K. L. Maehler). 1 ♀ ; Agaña airport, Guam; May 23, 1948 (K. L. Maehler).

Lestica (Solenius) constricta, new species

Crabro (*Ceratocolus*) *quadriceps* Bingham, Yasumatsu, 1939. Mushi **12**: 153, pl. 6, figs. 1-4 [♂ ; Babelthuap Island, Palaus; misidentification].

Crabro quadriceps Bingham, Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 51 [common in the Palaus].

Yasumatsu's description and figures agree in all essential respects with the series of males before me. There is, likewise, no doubt that the present species is distinct from the true *quadriceps* of Bingham. There are too many points of difference, in both sculpture and color, between Bingham's description of the female *quadriceps* and my series of three females of the present species. Furthermore, *quadriceps* has been placed in the synonymy of the widely distributed *alata* (Panzer), questionably by Kohl, 1915 (Ann. k. k. Naturhist. Hofmus. Wien **29**: 125), and definitely by Turner, 1912 (Ann. Mag. Nat. Hist. [8] **10**: 376), a species which belongs to the typical subgenus rather than to *Solenius.*

Later, Yasumatsu, 1942 (Mushi **14**: 90), recorded additional material of both sexes of *quadriceps* from China and Formosa. If these latter specimens are conspecific with Palau material, and I have no reason to doubt Yasumatsu's placing them together, *constricta* has a fairly extended range and probably will be found also in the Philippines. Therefore, the possibility exists that the species is not endemic in the Palaus, but was introduced perhaps from Formosa or the Philippines.

The present species appears to be most closely related to *Lestica* (*Solenius*) *wollmanni* (Kohl), new combination, from Turkestan (Kohl, 1915. Ann. k. k. Naturhist. Hofmus. Wien **29**: 121 [♀ ; described as *Crabro* (*Ceratocolus*)]), agreeing with that species in the very strongly constricted abdominal segments. The male described as the opposite sex of *wollmanni* by Kuznetzov-Ugamskij, 1927 (Zool. Anz. **71**: 244; [♂ ; Berkara, 70 km. west of Aulie-Ata in central Asia]), may be incorrectly associated, since it appears to belong to the subgenus *Clypeocrabro.* However, the distinctions between *Clypeocrabro* and *Solenius* seem difficult to maintain.

The female of *constricta* differs in having the postscutellum black (yellow in *wollmanni*) and the abdominal tergites one to five each with a pair of yellow spots, those of one, two and five being very narrowly separated in the middle (*wollmanni* has bands on one, four and five, lateral spots on two and three). Kohl mentions that the punctation of the abdominal tergites in *wollmanni* is sparser than in *clypeata* (Schreber), whereas the punctation in *constricta* is extremely close, much more so than in *clypeata.* Kohl does not mention the hind margins of the first five abdominal tergites in *wollmanni,* so I assume they are not reflexed in that species, whereas they are in *constricta.* The male which Kuznetzov-Ugamskij associates with *wollmanni* is at once

separated from the male of *constricta* by having the median flagellar segments longer than broad (about as long as broad in *constricta*) and in having the head much more narrowed behind the compound eyes, much as in *clypeata*.

Nothing is known of the habits of this species, but other members of the subgenus nest in stems of pithy plants or in old beetle borings and provision their nests with adult Diptera or Lepidoptera.

Type: ♂ ; northeast corner of Koror Island, Palaus; July 22, 1946 (H. K. Townes). [U. S. National Museum. Type No. 59035].

Male—Length 9 mm., forewing 5.9 mm. Black, rather dull from excessively close punctation, except temples, mesopleuron and second abdominal sternite which are shining; mandible near tip, hind tibia beneath, and hind tarsus above, castaneous; flagellum beneath, tegula, fore tarsus except basal segment, mid femur with a stripe on outer surface, mid tibia beneath, mid tarsus entirely, and hind tarsus beneath, ferruginous; scape except a spot at base behind, broad band along fore margin of pronotal disk narrowly interrupted in middle, pronotal lobe, small spot in middle of scutellum, transverse lateral spots on first to fifth tergites separated in middle by at least half the width of each segment, those of the second the largest and wider laterally, those of the fifth the smallest, mid femur with a stripe behind on outer surface, mid tibia on basal two-thirds of outer surface, and a stripe on outer side of hind tibia on nearly the entire length, flavous; mid coxa behind, hind coxa beneath on apical half, fore trochanter, fore femur except at base of outer surface, fore tibia, and fore basitarsus, stramineous. Front, vertex, dorsum of thorax and of abdomen with short, erect dark brown setae; clypeus, an oblique patch on lower temple parallel with hypostomal carina, lower inner eye margin, mesosternum, and a large, lateral rounded patch on second sternite with dense, short, appressed silvery hairs; remainder of temple, mesopleuron and second sternite with sparser, longer silvery subappressed hairs; fore coxa beneath, all trochanters beneath, fore femur beneath and on upper part of hind surface, and fore tibia beneath with dense, erect white hairs, those on fore femur the longest. Wings moderately infumated with brownish.

Head in frontal view obtrapezoidal, the ratio of height (from apex of clypeus to top of eye) to greatest width (near top of eye) to least width (at posterior mandibular condyle) about 14:13:9; mandible bidentate at tip; clypeus with median length 0.4 times its width, the median longitudinal ridge becoming broader and flattened at apex, the apical margin irregularly rounded, but not dentate; antennal scape ecarinate, three times the interocular distance across middle of antennal fossae, equal in length to the first six flagellar segments; the latter slightly broader than long except for the ultimate which is twice as long as broad, unmodified except for a series of carina-like tyloides beneath on the third to tenth; from above the head evenly narrowed behind eyes, the ratio of its greatest width to least width (just before occipital carina) to median length about 13:9:10; ocellocular distance equal to postocellar distance, the ocelli in an isosceles triangle, postocellar distance 1.5 times the anterolateral ocellar distance; temple broad, flat, its width across middle 1.5 times the width of eye at middle; scapal area glabrous, impunctate; inner eye margin, upper half of front, and vertex with coarse, contiguous punctures, those of vertex much larger; temple with large scattered punctures except an oblique patch of close, fine ones below; occipital carina foveate above, and again beneath near the hypostomal carina.

Pronotum anteriorly with a transverse, cristate carina, notched in middle and terminating laterally in a large tooth, the width at teeth equal to width of head at occiput; the dorsal surface with punctures contiguous and about as fine as on upper part of front, posteriorly strongly impressed and foveate; mesoscutum with punctures anteriorly as on dorsum of prothorax, toward the rear becoming larger; scutellum punctured like mesoscutum posteriorly; post-

scutellum in middle with dense, finer punctures; mesopleuron with large, deep punctures usually separated by about half the diameter of a puncture; metapleuron longitudinally rugulose; propodeum on lateral surface longitudinally rugulose with a few close punctures posteriorly, dorsal and posterior surface of propodeum rugosoreticulate, the posterior surface more finely so and with smaller reticulations.

Legs modified as follows: Fore leg except coxa flattened beneath, the trochanter lamellate but not toothed, the tarsi patellate, basitarsus with inner margin concave, outer convex, somewhat more than twice as long as width at apex or the following three segments united; mid femur short, its basal width half its length, the hind margin lamellate, mid tibia stout, strongly curved as viewed from side, the tarsi patellate, though not so thin as fore tarsi, the basitarsus concave on fore margin, straight on hind; hind basitarsus slightly flattened beneath, the fore margin convex.

Forewing with marginal cell almost four times as long as wide; first and second abscissae of radius equal in length; second abscissa of cubitus one-fourth the length of first abscissa, the latter subequal in length to transverse cubitus.

Abdomen with first four tergites with reflexed apical margins, the first to fifth just before apex, and the second to fifth at base, deeply constricted; second and third sternites at apex and third at base, constricted; the constricted areas of the first five tergites densely and rather minutely punctate, elsewhere with larger, subcontiguous punctures and glabrous interspaces; exposed parts of sixth and seventh tergites with moderately dense, small punctures, the seventh with a shallow longitudinal depression in middle.

The male paratypes vary in length from 8 to 9.5 mm. and differ from the above in that the median spot on the scutellum is evanescent or lacking in about half the series.

Allotype: ♀; same data as type. [U. S. National Museum.]

Female—Essentially very similar to male except in the details noted below.

Length 9 mm., forewing 6 mm.; all tarsi except basitarsi, ferruginous; scape entirely, pedicel beneath, dorsum of pronotum and scutellum almost entirely, broad lateral spots on first to fifth tergites, those of first, second and fifth very narrowly separated in middle, all basitarsi, all tibiae except hind one beneath, mid femur at apex and a band along hind margin of outer surface, hind coxa beneath, flavous; fore trochanter black; pubescence as in male except golden on clypeus, hair on mesosternum sparse, and legs lacking the modified dense brushes present in male.

Head in frontal view subquadrate, its greatest width one-fifth more than height from apex of clypeus to top of eye; mandible tridentate apically and with a small tooth at middle of inner margin; clypeus with median longitudinal ridge slightly broadened toward tip, the apical margin bidentate in middle and thickened; scape unicarinate, but very feebly so, twice as long as interocular distance across antennal fossae; flagellum without tyloides; head from above subrectangular, the greatest width 1.5 times the length in middle; ocelli in a low triangle, the postocellar distance equal to ocellocular distance and twice the anterolateral ocellar distance; punctation of head similar to male except temple densely and more minutely so on upper two-thirds.

Thoracic sculpture similar to male, but pronotal tooth weaker.

Legs without the sexual modifications of male.

Sculpture of abdomen similar to male; pygidium strongly narrowed toward apex, excavate on apical two-thirds and fringed by stiff erect setae.

Female paratypes differ in no way except that one is 9.7 mm. long.

Paratypes: 1 ♀, 1 ♂; same data as type. 3 ♂ ♂; same data as type, but July 20, 1946. 2 ♀ ♀, 5 ♂ ♂; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler). 1 ♀, 1 ♂; Peleliu Island,

Palaus; July 23, 1946 (H. K. Townes). One female and two male paratypes will be deposited in the B. P. Bishop Museum, Honolulu.

Dasyproctus immaculatus, new species

Rhopalum (?) sp. Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 51 [common in the Palaus].

The combination of the rather short petiole of first abdominal segment, transverse carina margining the facial concavity above, and the total absence of yellow maculations on body and appendages serves to separate *immaculatus* from the other known species of this genus. It is not at all closely related to *Dasyproctus philippinensis* Ashmead, its closest geographical relative, which has coarse punctures on upper part of front and vertex, a longer, more slender first abdominal segment, and extensive yellow maculations on body and appendages.

Nothing is known of the ethology of this species, but other members of the genus nest in flower stalks or old beetle borings, and provision them with adult Diptera.

Type: ♂; northeast corner of Koror Island, Palaus; July 20, 1946 (H. K. Townes). [U. S. National Museum, Type No. 59036].

Male—Length 6.7 mm., forewing 5.0 mm. Black, dull, mat, with greenish reflections, except postscutellum, metapleuron and propodeum shining. Vestiture silvery, dense, short and decumbent on clypeus and facial concavity, sparser, longer and erect on rest of body. Wings slightly infumated, nervures fuscous.

Head in frontal view with greatest width 1.74 times the distance from apex of clypeus to carina margining facial concavity above; clypeus with median ridge well-developed, extending almost to apical margin, the median produced part of clypeus narrow, slightly emarginate at apex; carina margining facial concavity crenulate posteriorly; head viewed from above subrectangular, the greatest width 1.5 times the distance from occiput to carina margining the facial concavity; ocelli in a low triangle, the postocellar distance slightly less than ocellocular distance; front with a delicate carina running from anterior ocellus to carina margining facial concavity, with scattered, minute punctures which are about twice as dense as those on vertex; temple near lower eye margin with a few short oblique carinae and also a strong ridge curving upward from posterior mandibular condyle and extending about one-third the height of temple; occipital carina well developed, foveate anteriorly on side and beneath head; pedicel and flagellum of antenna about twice the length of scape, flagellar segments two to eleven with tyloides beneath which are linear on the first two and ultimate one, broadened on the others.

Pronotum with anterior transverse carina weak, present only on lateral fourth, the pronotum deeply notched in middle; mesoscutum, mesopleuron and scutellum with scattered minute punctures, the latter coarsely foveate posteriorly; postscutellum with coarse, longitudinal carinae; metapleuron with a few strong, oblique carinae; propodeum with a narrow, median longitudinal furrow on dorsal and posterior surfaces, the dorsal surface with radiating ridges, the posterior surface with transverse ridges, the lateral surface margined above and behind by a strong carina and with numerous fine, oblique carinae on disk.

Legs without sexual modifications.

Forewing with marginal cell slightly over 3 times as long as wide; second abscissa of radius slightly longer than first; second abscissa of cubitus half the length of the first, the latter subequal to transverse cubitus.

Abdomen with first segment petiolate anteriorly, short, about 1.25 times the length of hind tibia, the petiole subequal in length to the gradually widened, moderately nodose posterior part, the width at apex about half the length of the segment, the petiole shining and rugulosopunctate, the nodose posterior section sparsely and minutely punctate as are tergites two to six; last tergite rather coarsely punctate, a vestigial pygidial area indicated by a short lateral carina on apical fourth; sternites unmodified, practically impunctate, the last sternite truncate apically.

The male paratypes vary in no essential detail from the above description.

Allotype: ♀ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler). [U. S. National Museum].

Female—Length 8.7 mm., forewing 5.9 mm. Essential details as in male, with the following exceptions: Metapleuron and propodeum dull, but not mat; sternum of abdomen shining. Punctation as fine as in male, but everywhere correspondingly somewhat denser.

Head viewed from above with greatest width 1.73 times the median length from occiput to carina margining facial concavity; lower third of temple with six to eight oblique carinae running between eye margin and ridge from posterior mandibular condyle.

Thorax with posterior part of scutellum with short longitudinal carinae, not foveate; posterior surface of propodeum with carinae longitudinal, instead of transverse.

Abdomen with pygidium excavate, punctate at base, strongly narrowed toward apex, fringed laterally by stiff erect setae.

The female paratype is 9.0 mm. long and agrees in all details of sculpture with the allotype.

Paratypes: 2 ♂ ♂ ; northeast corner of Koror Island, Palaus; July 22, 1946 (H. K. Townes). 1 ♀ ; same data as allotype (KLM). One male paratype will be deposited in the B. P. Bishop Museum, Honolulu.

Tachysphex bengalensis Cameron

Tachysphex bengalensis Cameron, 1889. Mem. Proc. Manch. Lit. Phil. Soc. (4) 2: 144 [♀ ; Tirhoot, India; type in London].

Tachysphex sp. Townes, 1946. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 50 [Palaus].

The present species is widely distributed in the Oriental region and recently has become established in Hawaii (Weber, 1948. Proc. Hawaii. Ent. Soc. 13: 203—erroneously reported as *bituberculatus* Cameron). The populations in the Palaus, Marianas and Hawaii probably originated from specimens introduced from the Philippines.

The habits of this species are unknown, but other members of the genus construct shallow burrows, usually in sandy soil, which they provision with Orthoptera.

MARIANA ISLANDS: 1 ♀, 2 ♂ ♂ ; Susupe, Saipan; January 1, 1948 (K. L. Maehler).

CAROLINE ISLANDS: 1 ♀ ; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes).

Dicranorhina species

F. X. Williams informs me that he observed several specimens belonging to this genus running in a characteristic high-legged fashion near his quarters while in the Palaus in June 1948. He describes the manner of running (1928. Bul. **19,** Ent. Ser., Expt. Sta. Hawaii. Sugar Pl. Assoc., p. 100) in *luzonensis* Rohwer as "a peculiar easy gait, the fore part of the body being raised considerably higher than the posterior." It is unlikely that an endemic species would have escaped capture by the several expeditions which visited the Palaus from 1936 to 1946 because of the semi-domiciliary habits of the known species, so it seems probable that the species seen by Williams is a recent introduction to the Palaus, perhaps *luzonensis* Rohwer.

Motes subtesselatus (Smith)

Larrada subtesselata Smith, 1856. Cat. Hym. Brit. Mus. **4**: 277 [♀ ; India, Sumatra, Java; type in London].

Notogonia manilensis Rohwer, 1910. Proc. U. S. Natl. Mus. **37**: 659 [♂ ; Manila, Luzon, Philippines; type in Washington]. New synonymy.

Notogonidea luzonensis Rohwer, 1919. Bul. **14,** Ent. Ser., Expt. Sta. Hawaii. Sugar Pl. Assoc. p. 9 [♀ ; Los Baños, Luzon, Philippines; type in Washington].

Motes subtesselatus (Smith) Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [Kwajalein].

Williams, 1928 (Bul. **19,** Ent. Ser., Expt. Sta. Hawaii. Sugar Pl. Assoc., p. 73), synonymizes *manilensis* (Rohwer) with *laboriosus* (Smith). An examination of the type shows that this is incorrect. Rohwer's type is a male of *subtesselatus* (Smith) and agrees with the characters cited in the foregoing key as well as those ascribed to *subtesselatus* by Williams (*loc. cit.*, pp. 70, 73). Williams (*loc. cit.*) is the authority for the other synonymy given above.

This common and widely distributed Oriental species was introduced into Hawaii from the Philippines over 25 years ago. Presumably the Marshall Islands population arose from specimens accidentally introduced there from Hawaii.

This species constructs tunnels in the soil and provisions the cells with crickets (Gryllidae).

MARSHALL ISLANDS: 1 ♀ ; no other locality; 1932 (on coconut flowers). 1 ♂ ; Kwajalein Island, Kwajalein Atoll; August 17, 1946 (H. K. Townes). 1 ♂ ; Kwajalein Island, November 2, 1946 (on leaves of *Wedelia biflora*).

Motes laboriosus (Smith), new combination

Larrada laboriosa Smith, 1856. Cat. Hym. Brit. Mus. **4**: 278 [♀ ; Philippines; type in London].

Notogonia crawfordi Rohwer, 1910. Proc. U. S. Natl. Mus. **37**: 659 [♀ ; Manila, Luzon, Philippines; type in Washington].

This is another common and widely distributed Oriental species probably established in the Marianas by way of the Philippines. Williams, 1928 (Bul. **19**, Ent. Ser., Expt. Sta. Hawaii. Sugar. Pl. Assoc., p. 73) is the authority for the above synonymy. The records from Micronesia are as follows:

MARIANA ISLANDS: 1 ♀ ; Hagoya Lake, Tinian; June 10, 1946 (H. K. Townes). 3 ♀ ♀ ; Tinian; June 13, 1946 (H. K. Townes). 1 ♀ ; Susupe, Saipan; January 1, 1948 (K L. Maehler). 1 ♀ ; Agricultural Farm, Guam; February 28, 1948 (K. L. Maehler). 1 ♂ ; Piti, Guam; March 13, 1948 (K. L. Maehler; on *Ipomoea*).

Motes manilae (Ashmead)

Notogonia manilae Ashmead, 1905. Proc. U. S. Natl. Mus. **28**: 130 [♀ , ♂ ; Manila, Luzon, Philippines; type in Washington].

Notogonia retiaria Turner, 1908 Proc. Zool. Soc. London, p. 479 [♀ ; Perth, Australia; type in London].

Notogonidea williamsi Rohwer, 1919. Bul. **14**, Ent. Ser., Hawaii. Sugar Pl. Assoc., p. 9 [♀ ; Los Baños, Luzon, Philippines; type in Washington].

Motes manilae (Ashmead) Yasumatsu, 1941. Mushi **14**: 44 [♀ from Pagan Island, Marianas; ♂ from Babelthuap Island, Palaus].—Towns, 1946. Rept. **14**, U. S. Comm. Co. Surv. Micronesia, p. 50 [Guam].

Notogonidea manilae (Ashmead) Swezey, 1942. B. P. Bishop Mus. Bul. **172**: 184 [Guam].

Williams, 1928 (Bul. **19**, Ent. Ser., Expt. Sta. Hawaii. Sugar Pl. Assoc., p. 75), and 1945 (Proc. Hawaii. Ent. Soc. **12**: 444) is the authority for the above synonymy. *M. manilae* is widely distributed in the Oriental and Australasian regions and is present on many of the Pacific islands. It nests in the soil and provisions the cells with small crickets (*Nemobius*).

MARIANA ISLANDS: 1 ♀ ; U S. Commercial Co. Farm, Saipan; June 17, 1946 (R. G. Oakley). 1 ♀ ; Mt. Santa Rosa, Guam; February 26, 1948 (K. L. Maehler). 1 ♀ ; same, but March 12, 1948. 1 ♂ ; Dededo, Guam; April 8, 1948 (K. L. Maehler). 1 ♂ ; Agaña, Guam; December 17, 1947 (K. L. Maehler). 1 ♀ ; same, but February 22, 1948 (on *Ipomoea*). 2 ♀ ♀ ; same, but March 10, 1948 (on *Passiflora foetida*). 1 ♀ ; Agaña airport, Guam; June 13, 1946 (H. K. Townes). 1 ♀ ; same, but May 26, 1948 (K. L. Maehler). 1 ♂ ; same, but May 23, 1948 (on *Ipomoea*). 1 ♀ ; Mt. Alutom, Guam; June 6, 1946 (H. K. Townes). 1 ♂ ; Yona, Guam; November 18, 1937 (R. G. Oakley). 1 ♂ ; Ylig, Guam; December 14, 1947 (K. L. Maehler; on *Scaevola*).

1 ♀ ; Talofofo, Guam; December 19, 1947 (K. L. Maehler). 1 ♀ ; Haputo Point, Guam; April 27, 1948 (K. L. Maehler). 1 ♀ ; Guam; 1937 (R. G. Oakley). 1 ♂ ; Tumon Bay, Guam; April 27, 1948 (K. L. Maehler).

CAROLINE ISLANDS: 1 ♂ ; Fefan Island, Truk Atoll; May 27, 1946 (H. K. Townes). 2 ♀ ♀ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler) [KLM].

Motes townesi,[6] new species

Motes sp. Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [Palaus].

The present species belongs to the difficult complex containing *manilae* (Ashmead), *tristis* (Smith), *samoensis* (Williams), *bakeri* (Williams), *ligulata* (Williams) and others. It is at once separable from all of them by the extremely sparse thoracic punctation. Apparently it is closest to *samoensis,* which differs in the male in genitalic features and shorter basal flagellar segments, in the female in the lack of silvery bands on abdomen, and in both sexes in the denser punctation of the thorax. Like *samoensis, townesi* is larger (♀ , 9.2 mm.; ♂ , 8.5 mm.) than the ubiquitous *manilae* (♀ , 6.5-8.3 mm.; ♂ , 5.0-6.5 mm.).

Type: ♀ ; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes). [U. S. National Museum, Type No. 59037.]

Female—Length 9.2 mm., forewing 6.7 mm. Black, shining; middle of mandible castaneous. Vestiture sparse, inconspicuous, short, fine silvery, mostly appressed on head, legs and abdomen, suberect on thorax; first three abdominal tergites with silvery bands on apical fourth; pygidium with short, dense, appressed silvery pubescence and scattered, long, fine suberect bristles. Wings slightly infumated and with iridescent reflections, veins fuscous.

Head: Produced part of clypeus with a shallow emargination in middle and no lateral notch, the bevel extending across apical third and with scattered punctures; front and vertex with delicate punctures, those on front separated by at least the width of a puncture, those on vertex denser, the callosities along inner eye margin impunctate, delicately shagreened; the least interocular distance on vertex 1.3 times the length of the first flagellar segment, the first two flagellar segments subequal in length.

Thorax: Mesoscutum with moderately large punctures many of which are separated by the width of a puncture (all subcontiguous in *manilae*); scutellum with finer punctures separated by several times the width of a puncture; postscutellum equally finely punctate, but more closely so; mesopleuron with extremely scattered, fine punctures; dorsum of propodeum regularly rugulosopunctate, formed chiefly from suboblique rugulae, the median longitudinal carina present only on basal half; posterior surface with fine transverse carinae, the central sulcus with raised margins which diverge strongly above in an arched line near dorsum.

Abdomen: Pygidium with sides slightly convex, the basal width about six-sevenths the length.

Wings: Marginal cell obliquely truncate, the relative lengths of the abscissae about 7:3:3:8:3.

Allotype: ♂ ; same data as type. [U. S. National Museum.]

[6] For H. K. Townes, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, in recognition of his diligent and thorough collecting in Micronesia.

Male—Length 8.5 mm., forewing 6.4 mm. Similar to female in color and vestiture, the punctation correspondingly somewhat denser.

Head: Apical margin of produced part of clypeus evenly rounded, not notched; scape plus first flagellar segment subequal to least interocular distance on vertex, the first flagellar segment slightly less than twice as long as width at apex.

Wings: Relative lengths of abscissae of marginal cell about 7:2:3:8:3.

Genitalia: Paramere similar in shape to *samoensis,* the apical half relatively narrower; in *manilae* the paramere is abruptly narrowed halfway to tip, but is rather evenly narrowed in *townesi* and *samoensis;* in *townesi* the bristles along outer margin of paramere at middle are denser than in *manilae.*

Liris opulenta (Lepeletier)

Sphex aurata Fabricius, 1787. Mant. Ins. **1**: 276 [East Indies; type in Kiel (?); preoccupied by Linnaeus, 1758].

Tachytes opulenta Lepeletier, 1845. Hist. Nat. Ins. Hym. **3**: 246 [♀, ♂; Java; type in Paris].

Liris aurata (Fabricius) Yasumatsu, 1937. Mushi **9**: 129 [Saipan Island, Marianas]. — Yasumatsu, 1940. Akitu **2**: 184 [Pagan Island, Marianas].—Yasumatsu, 1941. Mushi **14**: 45 [♀, ♂; Marianas].—Swezey, 1942. B. P. Bishop Mus. Bul. **172**: 184 [records from Guam].—Townes, 1946. Rpt. **14,** U. S. Comm. Co. Surv. Micronesia, p. 50 [Kwajalein, Marianas, Truk, Palaus].

This handsome wasp is widely distributed in the Ethiopian and Oriental regions and has become established on many of the Pacific islands including Hawaii (Weber, 1947. Proc. Hawaii. Ent. Soc. **13**: 22). Richards, 1935 (Trans. Roy. Ent. Soc. London **83**: 164), has pointed out that the Fabrician *Sphex aurata* was preoccupied by Linnaeus, and that the Fabrician species probably should be known as *opulenta* (Lepeletier). It has been recorded as nesting in the soil and storing large crickets (Gryllidae).

MARSHALL ISLANDS: 1 ♀; Kwajalein Island, Kwajalein Atoll; August 16, 1946 (H. K. Townes). 3 ♂ ♂; same data, but August 17, 1946. 2 ♂ ♂; same data, August 17, 1946 (R. G. Oakley).

MARIANA ISLANDS: 4 ♀ ♀; Guam; 1937 (R. G. Oakley). 1 ♀; Com Mar Hill, Guam; January 10, 1948 (K. L. Maehler). 1 ♀; Tinian; June 9, 1946 (H. K. Townes). 1 ♂; same data, but June 13, 1946 (H. K. Townes).

CAROLINE ISLANDS: 1 ♂; Moen Island, Truk Atoll; May 31, 1946 (H. K. Townes; possibly preys on *Conocephalus* or *Anaxipha* [Orthoptera]). 1 ♀; same data, but June 30, 1946 (K. J. Pelzer). Townes states that it was common also on Dublon Island, Truk Atoll, but no specimens were taken. 2 ♂ ♂; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes).

Liris esakii Yasumatsu

Liris esakii Yasumatsu, 1941. Mushi **14**: 46, pl. 1, figs. 1-3 [♀, ♂; Yap, Truk; type in Fukuoka, Japan].

This species is readily distinguished from the other Micronesian *Liris* by the combination of the strongly infumated wings, the sparser punctation of the mesoscutum, the radiating carinae on the dorsum of the propodeum, the dark brown pile on the female pygidium, and the almost total lack of carinae on the lateral surface of the propodeum of the male. Yasumatsu shows the male clypeus as having the margin of the produced part shallowly concave and without a central notch. My two males have a central notch, and the margin is subtruncate in one, and convex on each side of the central notch in the other, so there is considerable variation in this character.

CAROLINE ISLANDS: 2♀♀, 1♂; Moen Island, Truk Atoll; February 6, 1948 (K. L. Maehler). 1♂; same data, but February 7, 1948 (K. L. Maehler; in field). 1♂; Dublon Island, Truk Atoll; February 10, 1948 (K. L. Maehler; in field). 1♀; same date, but February 11, 1948. 1♀; Nif-Guilifez, Yap Island; September 7, 1939 (T. Esaki)—paratype.

Liris samoensis Williams

Liris samoensis Williams, 1928. Ins. Samoa, Hym., Pt. 5, Fasc. **1**, p. 36, text figs. 10-12 [♀, ♂; Samoa; type in London].—Yasumatsu, 1941. Mushi **14**: 45, pl. 1, fig. 4 [Ponape].

Yasumatsu records a single male from Ponape as this species. He states that the occipital carina is angulate lateroventrally instead of rounded as in other species of the genus. The Ponape specimen was not compared with Samoan material, and there is some possibility that the Ponape form is at least subspecifically distinct. The female of the Samoan form has the pygidial pile pale golden, which readily distinguishes it from the closely related *esakii* and *williamsi* which have dark brown pile on the pygidium. I have seen no material from Ponape, and the species is included in the key on the basis of a pair of paratypes made available by E. C. Zimmerman and R. H. Van Zwaluwenburg.

Liris williamsi,[7] new species

The present species is most closely related to *esakii* Yasumatsu. In addition to the hyaline wings and weaker oblique carinae on the dorsum of the propodeum, *williamsi* is separated from *esakii* by the relatively denser punctation of the mesoscutum and the better developed shoulder below the lateral angle of the produced part of the clypeus. This species is endemic in the Palaus.

Type: ♀; northeast corner of Koror Island, Palaus; July 22, 1946 (H. K. Townes). [U. S. National Museum, Type No. 59038.]

Female—Length 10.8 mm., forewing 9.2 mm. Black, head and thorax opaque, abdomen rather shining; tip of mandible castaneous. Vestiture rather sparse, very inconspicuous, fine, and silvery, appressed and rather dense on

[7] For F. X. Williams, formerly of the Hawaiian Sugar Planters' Association, in recognition of his many useful contributions to our knowledge of the wasps of Oceania.

clypeus and lower half of front, sparser and appressed on thorax, legs and abdomen, the thorax in addition with some longer, suberect hairs, first three abdominal tergites with a short, narrow strip of appressed silvery pubescence laterally at apex; pygidium with dense, short, appressed dark brown hairs, and a few suberect bristles. Wings hyaline and with iridescent reflections, the apices slightly infuscated, nervures black.

Head: Clypeus punctate almost to apical margin, the latter with a narrow median notch, and a small shoulder at lateral angle of produced part, the margin between notch and shoulder slightly convex, the apical third of clypeus shining and with larger punctures than the basal two-thirds which is dull from close, fine punctation; first and second flagellar segments subequal in length, the least interocular distance on vertex 1.13 times the length of the first flagellar segment.

Thorax: Mesoscutum with moderately large punctures, anteriorly somewhat closer than on the posterior three-fourths where they are separated by about the width of a puncture; scutellum with smaller punctures separated by about twice the width of a puncture; postscutellum more finely and rather closely punctate; mesopleuron shagreened; dorsal surface of propodeum with a well-defined shallow central sulcus which encloses a carina on basal half, elsewhere with weak, irregular oblique carinae; side of propodeum with a few oblique carinae on anterior half; posterior surface of propodeum with a narrow, impressed median line, above with a couple irregular transverse carinae, elsewhere scabrous.

Abdomen: Pygidium with sides slightly convex, the basal width about three-fifths the length.

Wings: Relative lengths of abscissae of marginal cell of forewing about 9:3:5:11:2.

Paratype: ♀; Koror, Palau Islands; March 15-25, 1948 (K. L. Maehler; in field). It is 10.5 mm. long and differs from the type in lacking a central carina on basal half of dorsum of propodeum. The paratype will be deposited in the B. P. Bishop Museum, Honolulu.

Liris (?) mindanaoensis carolinensis Yasumatsu

Liris mindanaoensis carolinensis Yasumatsu, 1941. Mushi **14**: 46, pl. 1, fig. 5 [♂; Tol Island, Truk Atoll; type in Fukuoka, Japan].

I have had to omit this form from the key because of lack of material and a suspicion that it may be placed in the incorrect genus. The measurements given by Yasumatsu (length: head 2.5 mm.; forewing 2.0 mm.; hind wing 1.5 mm. Width: head 1.5 mm.; thorax 2.0 mm.; abdomen 1.5 mm.) indicate a larrine wasp much smaller than any I have seen from Micronesia. Even the tiniest male *Motes manilae* (body length 5.0 mm.) known to me has a forewing 4.0 mm. in length. The known species of *Liris* are all much larger, no Micronesian males being less than 7.0 mm. long (forewing 6.0 mm.). Certainly if *carolinensis* is a true *Liris* it is specifically distinct from *mindanaoensis* which is almost as large as *opulenta*.

Solierella rohweri (Bridwell)

Silaon rohweri Bridwell, 1920. Proc. Hawaii. Ent. Soc. 4: 398, fig. [♀, ♂; Oahu; type in Honolulu].

This species, which nests in abandoned beetle borings in *Euphorbia* in Hawaii and provisions the nests with nymphs of *Nysius* (Lygaeidae), is apparently a recent migrant to the Marshalls. In the discussion accompanying the original description Bridwell suggests that the species may have been introduced into Hawaii, possibly from Central America. Krauss, 1945 (Proc. Hawaii. Ent. Soc. **12**: 317), made the above generic transfer.

MARSHALL ISLANDS: 1 ♂ ; Engebi Island, Eniwetok Atoll; May 18, 1946 (H. K. Townes and R. G. Oakley).

Trypoxylon philippinense Ashmead

Trypoxylon philippinensis Ashmead, 1904. Canad. Ent. **36**: 283 [♂ ; Manila, Luzon, Philippines; type in Washington].

This Philippine species was established in Hawaii as early as 1914 (Swezey, 1915. Proc. Hawaii. Ent. Soc. 3: 86). Swezey reports that it builds clay cells in sheltered situations and provisions them with spiders. The specimen listed below was collected on Guam, but apparently may not have become established for it has not been taken in recent years.

MARIANA ISLANDS: 1 ♀ ; Root Farm, Guam; August 25, 1938 (R. G. Oakley; flying in office).

Pison punctifrons Shuckard

Pison punctifrons Shuckard, 1837. Trans. Ent. Soc. London 2: 77 [♀ ; India or St. Helena; type in Oxford].—Yasumatsu 1937. Mushi **9**: 134 [♀ ; Palaus]. — Yasumatsu, 1939. Festschr. 60 Geburtst. E. Strand **5**: 83.

Pison suspiciosus Smith, 1858. Jour. Proc. Linn. Soc. Zool. 2: 104 [♀ ; Singapore; type in Oxford].

Pison fabricator Smith, 1869. Trans. Ent. Soc. London, p. 297 [♀ ; Hong Kong; type in London].

Pison striolatum Cameron, 1896. Mem. Manch. Lit. Phil. Soc. **41**: 82 [♀ ; Mussouri; type in Oxford].

Pison lagunae Ashmead, 1904. Proc. U. S. Natl. Mus. **28**: 131 [♂ ; Laguna de Bay, Luzon, Philippines; type in Washington].—Swezey, 1942. B. P. Bishop Mus. Bul. **172**: 185 [records from Guam]. New synonymy.

Pison javanus Cameron, 1905. Tijd. f. Ent. **48**: 63 [♂ ; Java; type in Amsterdam].

Pison sp. Fullaway, 1913. Hawaii. Ent. Soc., Proc. **2**: 283 [Guam].

The above synonymy is based on Turner, 1916 (Proc. Zool. Soc. London, p. 625, sp. 81), except that *lagunae* Ashmead, of which I have seen the type, is also placed in synonymy. Turner had treated the latter as a possible synonym (*loc. cit.*, sp. 83). This is one of the most widely distributed and easily recognized *Pison* occurring in Micronesia. It is not an endemic species.

The species constructs either free clay cells or partitions holes in timber and provisions the cells with small spiders.

MARSHALL ISLANDS: 1 ♂ ; Japtan Island, Eniwetok Atoll; May 15, 1946 (H. K. Townes).

MARIANA ISLANDS: 1 ♀ ; Agrihan Island; August 6, 1945 (D. J. Borror). 1 ♀ ; same data, but August 7, 1945. 2 ♀ ♀ ; Saipan; June 28, 1946 (H. K. Townes). 1 ♀ ; same data, but December 20, 1944 (Smith). 1 ♂ ; Tinian; June 9, 1946 (H. K. Townes). 1 ♂ ; same data, but June 11, 1946 (R. G. Oakley). 1 ♀ , 1 ♂ ; Hagoya Lake, Tinian; June 10, 1946 (H. K. Townes). 1 ♀, 3 ♂ ♂ ; Guam (D. T. Fullaway). 2 ♂ ♂ ; Agaña, Guam; December 15, 1947 (K. L. Maehler; on *Thespesia populnea*). 1 ♀ , 1 ♂ ; same data, but December 17, 1947. 1 ♂ ; Point Oca, Guam; July 1945 (J. L. Gressitt and G. E. Bohart).

CAROLINE ISLANDS: 1 ♂ ; Machiro Island, Kapingamarangi Atoll; August 4, 1946 (H. K. Townes). 1 ♀ ; near Yaptown, Yap Island; July 14, 1946 (H. K. Townes). 1 ♂ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler). 1 ♀ , 2 ♂ ; Melekeiok, Babelthuap Island, Palaus; April 7, 1936 (Z. Ono) [BPB]. 1 ♂ ; Ogiwal, Babelthuap Island, Palaus; April 10, 1936 (Z. Ono) [BPB].

Pison esakii Yasumatsu

Pison sp. Fullaway, 1913. Proc. Hawaii. Ent. Soc. **2**: 283 [Guam].—Swezey, 1942. B. P. Bishop Mus. Bul. **172**: 185 [Guam].

Pison esakii Yasumatsu, 1937. Mushi **9**: 129, fig. [♀ ; Rota; type in Fukuoka].

Pison Esakii Yasumatsu, 1939. Festchr. 60 Geburtst. E. Strand **5**: 83.

The strongly infumated wings and erect black hairs on head and thorax readily separate this handsome wasp, endemic in the Marianas, from all others in Micronesia. Peculiarly enough the male is still unknown, though it should be easily recognized, since it probably has the same characters of coloration and pubescence. The species is rare in collections and I suspect must be a sylvicolous species.

MARIANA ISLANDS: 1 ♀ ; Guam (D. T. Fullaway). 1 ♀ ; Point Ritidian, Guam; April 16, 1936 (E. H. Bryan, Jr.). 1 ♀ ; same data, but June 1945 (J. L. Gressitt). 1 ♀ ; Piti, Guam; June 12, 1936 (O. H. Swezey; at light). 2 ♀ ♀ ; Mt. Alifan, Guam; June 27, 1936 (O. H. Swezey). 1 ♀ ; Tinian; June 9, 1946 (H. K. Townes). Occurs also on Rota (type locality).

Pison nigellum, new species

The present species, endemic on Ponape, is the only Micronesian *Pison* except the Guam *esakii* with erect black pubescence on the

head and thorax. It differs from *esakii*, *inter alia*, in the smaller size, the more or less pentagonal clypeal lobe, details of the propodeal sculpture and hyaline wings.

Type: ♀ ; near hydroelectric plant, Colonia, Ponape; August 9, 1946 (H. K. Townes; along roads, stream banks and bottomland native vegetation). [U. S. National Museum, Type No. 59039.]

Female—Length 8.0 mm., forewing 6.2 mm. Black, head opaque, thorax and abdomen shining; mandible castaneous near tip. Erect vestiture short, black, moderately dense on head and thorax, very sparse on abdomen; clypeus and lower half of front with appressed, short, dense silvery pubescence, abdomen with much sparser, shorter appressed silvery hairs and without apical hair-bands; tibial calcaria black. Wings hyaline and with iridescent reflections, stigma and veins black.

Head: Clypeal lobe impunctate, more or less pentagonal in outline, about one-third the greatest width of clypeus; front finely granulate and with superimposed small, shallow punctures mostly separated by somewhat more than the diameter of a puncture; an evanescent longitudinal groove running from anterior ocellus half the distance toward antennal insertions and terminating in a short polished streak; vertex about as finely punctate as front, but the punctures separated by about the diameter of a puncture; shortest distance between eyes at lower ends (across middle of clypeus) 2.2 times the shortest interocular distance on vertex; ocellocular distance one-sixth the diameter of a posterior ocellus and one-fourth the postocellar distance; ratio of lengths of first three segments of flagellum about 13:12:12; least interocular distance on vertex equal to length of first flagellar segment.

Thorax: Mesoscutum with punctures equal in size to those on front, anteriorly separated by about the diameter of a puncture, posteriorly by more than the diameter of a puncture; scutellum and postscutellum with finer, more separated punctures; mesopleuron with punctures equal in size to those on mesoscutum, usually separated by somewhat more than the diameter of a puncture; metapleuron with minute punctures, those on upper third closer together; dorsum of propodeum with sparse, minute punctures, a few very short radiating carinae at base, the median longitudinal carina weak, extending over anterior half only, contained in a very shallow sulcus which is deeper posteriorly; lateral surface of propodeum with minute punctures which are closer than on dorsum, no carina separating lateral from dorsal and posterior surfaces; the latter with the usual deep impression in middle, some scattered fine punctures and above insertion of muscle a few short, transverse carinae interrupted at midline.

Abdomen: Tergites with minute scattered punctures, the first five very slightly constricted at apex; second sternite practically impunctate.

Wings: Forewing with petiole of second submarginal cell 1.4 times the height of cell; first recurrent vein interstitial with first transverse cubital vein, the second slightly distad of the second transverse cubital.

Female paratypes vary in length from 7.0 to 8.5 mm., and differ from the above description in no important details, except that occasionally the first recurrent vein in the forewing is received proximad of the first transverse cubital vein.

Allotype: ♂ ; Ponape; March 14, 1936 (Z. Ono). [B. P. Bishop Museum.]

Male. Length 7.2 mm., forewing 5.4 mm. Similar to the type in color, vestiture and sculptural characters with the following exceptions.

Head: Clypeal lobe pentagonal in shape, but the apex more narrowly rounded; shortest distance between eyes at lower ends (across middle of

clypeus) 1.7 times the shortest interocular distance on vertex: ocellocular distance about one-third the diameter of a posterior ocellus and one-half the postocellar distance; least interocular distance on vertex about 1.5 times the length of the first flagellar segment.

Thorax: Punctation correspondingly somewhat sparser than in female.

Abdomen: Third sternite without a median tubercle or ridge; second to fifth sternites with low, rounded, transverse, posterolateral ridges, those of third the longest and strongest, those of fifth very short; hypopygium with surface flat, clothed with stout bristles on exposed part, the apical margin truncate.

Wings: First recurrent vein slightly proximad of first transverse cubital vein, second recurrent slightly distad of second transverse cubital.

Paratypes: 1 ♀ ; same data as type [USNM]. 1 ♀ ; Kolonie, Ponape; February 2, 1936 (Z. Ono). 5 ♀ ♀ ; Ronkiti, Ponape; February 4, 1936 (Z. Ono). 1 ♀ ; Wone, Ponape; February 11, 1936 (Z. Ono). 3 ♀ ♀ ; Roi, Ponape; February 14, 1936 (Z. Ono). 1 ♀ ; Reitao, Ponape; March 1, 1936 (Z. Ono). 2 ♀ ♀ ; Tamon-Reitao, Ponape; March 1, 1936 (Z. Ono). 7 ♀ ♀ ; Ponape; March 14, 1936 (Z. Ono) [BPB].

Pison argentatum Shuckard

Pison (Pisonitus) argentatus Shuckard, 1837. Trans. Ent. Soc. London **2**: 79 [♀ ; Mauritius; type in Oxford].

Pison fuscipalpis Cameron, 1901. Proc. Zool. Soc. London **2**: 27 [♀ ; Singapore; type in London].

Pisonitus argenteus Ashmead, 1904. Proc. U. S. Natl. Mus. **28**: 131 [♀ ; Bacoor, Philippines; type in Washington].

Pison argentatum Shuckard, Swezey, 1942. B. P. Bishop Mus. Bul. **172**: 185; [Guam; parasitized by *Melittobia;* stores small spiders].

The present species and *ignavum* Turner are easily distinguished from other *Pison* occurring in Micronesia by the pale tibial calcaria, extremely dense silvery pubescence and the second recurrent vein being received in the middle of the second submarginal cell. *P. argentatum* is smaller (aver. length, ♀-6 mm., ♂-5 mm.) than *ignavum* (aver. length, ♀-8 mm., ♂-7 mm.), the punctation is finer though equally dense, the apical margin of the clypeal lobe is not depressed in the middle in the female, and the oblique carinae on the dorsum of the propodeum are weaker and tend to become evanescent toward the margins. The present species is more widely distributed than any other *Pison*, occurring in the Ethiopian and Oriental regions, and on various Pacific islands east to Hawaii. It constructs free clay cells in sheltered situations which it provisions with small spiders.

MARIANA ISLANDS: 2 ♀ ♀, 3 ♂ ♂ ; Pago, Guam; May 9, 1945 (J. L. Gressitt and G. E. Bohart). 1 ♂ ; Talofofo, Guam; February 26, 1948 (K. L. Maehler).

CAROLINE ISLANDS: 1 ♀ ; Dublon Island, Truk Atoll;

February 10, 1948 (K. L. Maehler; reared from clay cells in church; parasitized by *Melittobia hawaiiensis* Perkins [Chalcididae]). 1 ♀; Ronkiti, Ponape; February 4, 1936 (Z. Ono) [BPB].

Pison ignavum Turner

Pison ignavum Turner, 1908. Proc. Zool. Soc. London, p. 511 [♀, ♂; Australia; type in London].

Pison argentatum ignavum Turner, 1916. Proc. Zool. Soc. London, p. 601 [recorded from Australia and Fiji].

The present species has been recorded from Australia, New Caledonia, Fiji, Society Islands, Samoa and the Marquesas. I agree with Williams, 1932 (B. P. Bishop Mus. Bul. **98**: 152-153) in treating it as a species distinct from, though uncomfortably close to, *argentatum* Shuckard. Like the latter, it builds free clay cells in sheltered situations which it provisions with small spiders.

CAROLINE ISLANDS: 1 ♂; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler).

Pison hospes Smith

Pison hospes Smith, 1879. Jour. Linn. Soc. Zool. **14**: 676 [♀, ♂; Hawaii; type in London].

Pison fuscipennis Smith, Yasumatsu, 1937. Mushi **9**: 131, pl. 10, figs. 3, 4 [♀, ♂; Palaus; misidentification of Smith species].—Yasumatsu, 1939. Festschr. 60 Geburtst. E. Strand **5**: 83.

Pison palauensis Yasumatsu, 1937. Mushi **9**: 133 [*nomen nudum* occurring in description of *Pison korrorensis*].

The comparatively large size, triangular clypeal lobe, and dense punctation of mesopleuron and second abdominal sternite distinguish the present species from others occurring in Micronesia. The Marshall Islands populations may have arisen from migrants from Hawaii. The species was present in the Palaus as early as 1936.

Yasumatsu's description and figures of what he calls *fuscipennis* Smith agree with specimens of the present species. The species does run to *fuscipennis* in Turner's table to the Australian species (1916, Proc. Zool. Soc. London, pp. 595-599), but *hospes* is not included in that key. Since Turner apparently knew both species and treated them as distinct I shall follow him. Turner does mention (*loc. cit.*) that *hospes* "is doubtfully distinct from *P. pallidipalpis* Smith." The latter name has precedence if the two are conspecific.

MARSHALL ISLANDS: 1 ♀, 1 ♂; Airek Island, Ailinglapalap Atoll; August 26, 1946 (H. K. Townes). 1 ♀; Imrodi Island, Jaluit Atoll; August 24, 1946 (H. K. Townes).

CAROLINE ISLANDS: 1 ♀, 1 ♂; Peleliu Island, Palaus (Z. Ono) [BPB]. 1 ♀; Peleliu Island, Palaus; July 23, 1946 (H. K.

Townes). 3 ♀ ♀ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler). 1 ♀ ; Palau Islands; April 8, 1936 (Z. Ono) [BPB]. 1 ♀ ; Airai, Palaus; April 17, 1936 (Z. Ono) [BPB].

Pison tahitense Saussure

Pison tahitense Saussure, 1867. Reise d. Novara, Zool. 2, Hym., p. 65 [♀ , ♂ ; Tahiti; type in Geneva (?)].

Pison Rechingeri Kohl, 1908. Denkschr. Akad. Wiss. Wien **81**: 309 [♀ , ♂ ; Samoa; type in Vienna (?)].

Apparently this is a recent introduction to Micronesia. Previously it was known from the Fijis, Samoa, Society Islands, Ellice Islands and the Marquesas. Its closest relatives in Micronesia are *hospes* and *ponape,* from which it may be distinguished by a combination of the infumated wings, well-developed median carina on dorsum of propodeum, and the sculpture of the posterior surface of the propodeum and second abdominal sternite.

MARSHALL ISLANDS: 1 ♀ ; Bigatyelang Island, Ailinglapalap Atoll; August 25, 1946 (H. K. Townes).

Pison ponape, new species

The present species, known from the female only, forms with *hospes* and *tahitense* a group rather well segregated from the other Micronesian species. The group is distinguished by the subcontiguous punctation of mesopleuron, lack of oblique carinae on dorsum of propodeum, unmodified third abdominal sternite of males, and the rather large size, females averaging over 9 mm. in length and the known males over 8 mm. In addition to the characters listed in the key as distinguishing *ponape* from *hospes* and *tahitense,* it has a prominent apical band of silvery pubescence on only the first tergite, whereas the latter two species have such bands on the first four tergites in the females.

Like *nigellum, ponape* appears to be an endemic species on Ponape and is found in areas of native vegetation.

Type: ♀ ; near hydroelectric plant, Colonia, Ponape; August 9, 1946 (H. K. Townes; along roads, stream banks and bottomland native vegetation). [U. S. National Museum, Type No. 59040.]

Female. Length 9.5 mm., forewing 7.5 mm. Black, head opaque, thorax and abdomen shining; apical half of mandible castaneous. Vestiture silvery (brownish on mesoscutum), short, suberect and moderately dense on clypeus and temples, short and erect on rest of head, longer and erect on thorax, short and decumbent on legs and abdomen, moderately dense on legs, very sparse on abdomen, only the first tergite with a noticeable apical band; tibial calcaria black. Wings clear hyaline and with iridescent reflections, stigma and veins black.

Head: Clypeal lobe impunctate, the apical margin rounded, about 0.4 times the greatest width of clypeus; front finely granulate and with superimposed small, shallow punctures separated by about the width of a puncture; frontal groove moderately well developed and extending from anterior ocellus half the distance toward antennal insertions and terminating in a very small tubercle; vertex about as finely punctate as front, but the punctures separated

by about half the diameter of a puncture; shortest distance between eyes at lower ends (across middle of clypeus) 1.9 times the shortest distance between eyes on vertex; ocellocular distance half the diameter of a posterior ocellus and about two-thirds the postocellar distance; relative lengths of first three flagellar segments about 13:11:11; least interocular distance on vertex slightly greater than length of first flagellar segment.

Thorax: Mesoscutum with punctures about twice as wide as on front, many of them separated by less than the diameter of a puncture; scutellum with smaller, somewhat sparser punctures; postscutellum with very small, dense punctures; mesopleuron with subcontiguous punctures equal in size to those on mesoscutum; metapleuron above with several close, longitudinal carinae, elsewhere with small, moderately dense punctures; lateral surface of propodeum separated from dorsal and posterior surfaces by a carina extending from near spiracle almost to apex of segment; dorsal surface with median carina absent, the median sulcus moderately deep, slightly widened toward apex, rest of surface with punctures slightly smaller than on mesoscutum, denser laterally; lateral surface with large, subcontiguous punctures; posterior surface with the usual deep impression on upper half, punctate laterad of this impression, the lower half impunctate and with four strong transverse rugae.

Abdomen: Tergites with minute, rather dense punctures, the second to fifth slightly constricted at apex; second to fifth sternites with slightly larger punctures, those on second separated by several times the diameter of a puncture, those on succeeding sternites progressively more closely punctate.

Wings: Forewing with petiole of second submarginal cell 1.3 times the height of cell; first recurrent vein received near apex of first submarginal cell, second recurrent interstitial with second transverse cubital vein.

Female paratypes vary in length from 9.0 to 10.5 mm. and differ from the above description as follows: Two have the frontal tubercle a short Y-shaped process; first recurrent vein of forewing is interstitial with first transverse cubital vein in one specimen; one specimen, probably a callow, has the hind legs and abdomen castaneous; and the number of strong transverse rugae on the posterior surface of the propodeum varies from four to six.

Paratypes: 1 ♀; same data as type, but August 13, 1946 (H. K. Townes) [USNM]. 1 ♀; Choptokoi, Ponape; February 10, 1936 (Z. Ono). 1 ♀; Tolocolme, Ponape; February 15, 1936 (Z. Ono). 1 ♀; Tamon, Ponape; February 27, 1936 (Z. Ono). 1 ♀; Tamon-Reitao, Ponape; March 1, 1936 (Z. Ono). 1 ♀; Ponape; March 14, 1936 (Z. Ono) [BPB].

Pison oakleyi,[8] new species

Pison sp. Fullaway, 1913. Proc. Hawaii. Ent. Soc. 2:283 [Guam].—Swezey, 1942. B. P. Bishop Mus. Bul. **172**:185 [Guam].

The shining, nonshagreened interspaces on the mesopleuron, strongly infumated wings and low rounded tubercle near middle of third abdominal sternite of male readily distinguish the present

[8] For R. G. Oakley, Division of Foreign Plant Quarantine, Bureau of Entomology and Plant Quarantine, whose collecting on crop plants in Micronesia forms an important supplement to the material collected by H. K. Townes on native vegetation.

form from the closely related *iridipenne* and *korrorense*. Like the other endemic Micronesian *Pison*, *ponape*, *nigellum*, and *esakii*, this is an inhabitant of the native forests.

Type: ♂ ; Point Ritidian, Guam; June 1945 (J. L. Gressitt). [U. S. National Museum, Type No. 59041.]

Male. Length 6.1 mm., forewing 4.9 mm. Black, shining except head opaque; mandible at tip castaneous. Vestiture sparse, silvery, shining, less noticeable than in *iridipenne*, decumbent on head, legs and abdomen, suberect on thorax, the apical bands on first to fourth tergites narrower and not so dense as in *iridipenne;* tibial calcaria black. Wings strongly infumated with brown and with violaceous reflections, stigma and veins fuscous.

Head: Impunctate clypeal lobe a low triangle in outline; shortest distance between eyes at lower ends (across middle of clypeus) greater than shortest interocular distance on vertex (5.75:4); front granulate and with numerous small, shallow, subcontiguous punctures, the interspaces not so close as to form a network of fine carinae as in *korrorense*; frontal groove present but weak, running from anterior ocellus half the distance toward antennal insertions and terminating in a short carina; punctures of vertex slightly finer than on front, and separated by about the width of a puncture; postocellar distance about twice the ocellocular distance and three-fifths the diameter of a posterior ocellus; relative lengths of first three flagellar segments about 10:9:8; shortest interocular distance on vertex very slightly more than the first and second flagellar segments combined.

Thorax: Mesoscutum about as finely and sparsely punctate as vertex, the scutellum and postscutellum equally finely punctate, the latter more sparsely so; mesopleuron with punctures slightly larger than on mesoscutum, usually separated by about the width of a puncture; metapleuron minutely punctate, the upper third more densely so; lateral surface of propodeum separated from dorsal and posterior surfaces by a carina extending almost from the apex of the segment to a point on the dorsal surface halfway to the spiracle; dorsum of propodeum with median carina weak, present only on anterior half, the sulcus also weak but extending to apex, remainder of surface with sparse, delicate punctures separated by several times the width of a puncture (much sparser than in *iridipenne*) and without traces of oblique, discal carinae; lateral surface with slightly larger and much denser punctures; posterior surface with the usual median impression, the upper half with sparse, small punctures, the lower half with a few transverse rugae.

Abdomen: Tergites one to five slightly constricted at apices and with delicate punctures separated by several times the width of a puncture; sternites with the second somewhat more sparsely punctate than the second tergite, the succeeding sternites progressively more densely punctate than the second; third sternite with a small, low rounded tubercle on midline at about the basal third; hypopygium with a rounded impression near the apex, the apical margin broadly and very shallowly emarginate.

Wings: Forewing with petiole of second sumarginal cell subequal to height of cell; first and second recurrent veins interstitial with first and second transverse cubital veins.

Male paratypes vary in length from 5.6 to 6.8 mm. and the first recurrent vein of forewing is proximad of first transverse cubital vein in two specimens.

Allotype: ♀ ; Mt. Alutom, Guam; June 18, 1946 (H. K. Townes). [U. S. National Museum.]

Female. Length 8.1 mm., forewing 6.1 mm. Similar to type male except as follows: Clypeal lobe with apical margin broadly rounded; shortest distance between eyes at lower ends (across middle of clypeus) 2.3 times the

least interocular distance on vertex; postocellar distance about one-third the diameter of a posterior ocellus; relative lengths of first three flagellar segments about 6:5:5; the shortest interocular distance on vertex slightly more than the length of first flagellar segment; third abdominal sternite not tuberculate.

Paratype females show some variation in the details of venation, occasionally the first recurrent vein being received proximad of the first transverse cubital vein, or the second recurrent distad of the second transverse cubital. The two females from Rota Island have less strongly infumated wings, but are otherwise identical. Additional material from Rota may establish the presence of a distinct subspecies on that island. Paratype females vary in length from 7.0 to 8.1 mm.

Paratypes: 1 ♂ ; same data as type. 1 ♀, 1 ♂ ; Guam (D. T. Fullaway). 2 ♀ ; Ritidian Point, Guam; April 7, 1948 (K. L. Maehler; near damp mud bank). 1 ♀ ; North Field, Guam; March 7, 1948 (K. L. Maehler). 2 ♀ ; Haputo Point, Guam; March 10, 1948 (K. L. Maehler) [KLM]. 3 ♀ ; Haputo Point, Guam; March 14, 1948 (K. L. Maehler; in damp mud on trail). 1 ♀ ; same data, but March 27, 1948. 1 ♀ ; same data, but April 29, 1948 (K. L. Maehler; visiting Chinese ink berry). 1 ♀ ; Tarague, Guam; May 17, 1936 (O. H. Swezey). 1 ♀ ; Machanao, Guam; June 30, 1936 (R. L. Usinger). 1 ♀ ; Mt. Alutom, Guam; July 6, 1946 (H. K. Townes). 1 ♀, 1 ♂ ; Talofofo, Guam; June 16, 1946 (H. K. Townes; edge of native forest). 1 ♂ ; Talofofo, Guam; December 19, 1947 (K. L. Maehler; on taro leaves). 1 ♀ ; Sabana, Rota; June 19, 1946 (H. K. Townes; along roadside). 1 ♀ ; Rota; July 26, 1946 (R. G. Oakley). Two female and one male paratypes will be deposited in the B. P. Bishop Museum, Honolulu.

Pison iridipenne Smith

Pison iridipennis Smith, 1879. Jour. Linn. Soc. Zool. **14**: 676 [♀, ♂ ; Honolulu, Hawaii; type in London].

Typical *iridipenne* apparently occurs only in the Fijis, Samoa, Society Islands, Tuamotus, Hawaii, and the localities in Micronesia listed below. Williams, 1947 (Occ. Papers B. P. Bishop Mus. **18**: 331), states that it has been recorded also from Australia, but I can find no other published record to this effect. Specimens from the Philippines are not typical *iridipenne*. It is a member of an exceedingly difficult assemblage of closely related species or subspecies of which females seem almost identical. The males of this group differ especially in the character of the third abdominal sternite, some having it unarmed, others having a median tubercle, a pair of tubercles, or a short transverse ridge. I suspect that adequate populations may show that many of the forms now considered as species, such as *korrorense* Yasumatsu, may have to be reduced to subspecific rank.

This species has been recorded as nesting in holes in timber, or partitioning clay cells of *Sceliphron*. The cells are provisioned with small spiders.

MARSHALL ISLANDS: 8 ♀ ♀ ; Airek Island, Ailinglapalap Atoll; August 26, 1946 (H. K. Townes).

MARIANA ISLANDS: 1 ♂ ; Hagoya Lake, Tinian; June 10, 1946 (H. K. Townes). 1 ♀ ; Tinian; June 8, 1946 (H. K. Townes). 1 ♀ ; Marpo Valley, Tinian; June 8, 1946 (R. G. Oakley). 1 ♀ ; Mt. Lasso, Tinian; June 12, 1946 (H. K. Townes; on leaves of *Melanolepis multiglandulosa*).

CAROLINE ISLANDS: 1 ♀ ; Mt. Tafeyät, Kusaie Island; July 21, 1946 (H. K. Townes; primary forest, 800-1200 ft. alt.). 1 ♀ ; Tamon, Ponape Island; February 27, 1936 (Z. Ono) [BPB]. 1 ♀ ; Dublon Island, Truk Atoll; February 10, 1948 (K. L. Maehler). 1 ♀ ; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes).

Pison korrorense Yasumatsu

Pison korrorensis Yasumatsu, 1937. Mushi **9**: 133, pl. 10, fig. 5 [♀, ♂ ; Koror Island, Palaus; type in Fukuoka, Japan].—Yasumatsu, 1939. Festschr. 60 Geburtst. E. Strand **5**:83.

As stated under the discussion of *iridipenne*, the present species may eventually have to be treated as a subspecies of the former when adequate material is at hand. I have seen only one female of this complex from the Palaus (Peleliu Island), and it appears to be identical with typical *iridipenne*. Yasumatsu's description of the female of *korrorense* offers no points of distinction between it and *iridipenne*. The male is quite distinct from *iridipenne* in the bituberculate third abdominal sternite and punctation of front. I am unable to say whether the latter character is the same in the female. My male of *korrorense* also has the dorsum of the propodeum entirely without oblique discal carinae, but since their development is subject to some variation in *iridipenne*, though seemingly always present to some extent, I have not attempted to use it as a key character. Judging from Yasumatsu's description of the female, the dorsum of the propodeum is the same as in my male.

CAROLINE ISLANDS: 1 ♂ ; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler).

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A Revised List of Host Plants of the Melon Fly in Hawaii[1]

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(Presented at the meeting of December 8, 1947)

A half-century ago the melon fly (*Dacus cucurbitae* Coq.) entered Hawaii and has since become the most important pest of cucurbits. However, it does not restrict its activity to the cucurbits alone, but infests plants in several other botanical families as well. A list of 10 host plants of melon fly in Hawaii was presented by Van Dine in 1906 and in 1908. In 1914 a list of 13 host plants was recorded by Severin *et al.* In 1917 and 1918, Back and Pemberton brought out more complete lists of 21 and 22 plants respectively. Since Back and Pemberton's work on the biology of the melon fly, no additional host list has been reported in Hawaii. The following list is presented to include several new hosts and also to revise the list presented by Back and Pemberton. The list of host plants in Hawaii is given in table 1. In table 2 is presented a list of plants which are not as yet recorded as hosts of the melon fly in Hawaii but which have been reported as such in other countries.

The extent of injury that may result from the attack of the melon fly depends upon the number of melon flies, the abundance and attractiveness of the hosts, the resistance of hosts to oviposition, and the development of larvae within the hosts. In table 1 the host plants are separated into five groups. The first three groups have been separated on the basis of the frequency of injury under general field conditions. The first group includes the highly susceptible plants, the fruits of which are frequently infested by the melon fly. The plants in the second group are infested only occasionally, and in general not all their fruits are injured. The plants in the third group are rarely infested and the fourth group includes the host plants that are not being cultivated. It is apparent that the position of some of these plants may vary depending on the availability of favorable hosts and on the population of the melon fly. For example, beans and peppers are heavily infested when the melon fly population is high and when more susceptible hosts are lacking.

Most of the plants in the first four groups have been confirmed by us, and our colleagues in the University and Bureau of Entomology and Plant Quarantine's Fruit Fly Investigations Laboratory at Honolulu, as hosts of melon fly.[2] The remaining plants have been reported from reliable sources. Wherever there is a

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[2] For additional information regarding investigations on the melon fly see University of Hawaii Agricultural Experiment Station Biennial Reports 1942-1944 and 1944-46.

doubt as to the validity of a host record, the plant has been placed in the fifth group of "doubtful hosts."

For every host record the reference from which the record has been obtained is cited. Nearly all the scientific names given in the tables have been inserted by the present authors. These names have been obtained from the "Manual of Cultivated Plants" and "The Standard Cyclopedia of Horticulture" by L. H. Bailey (1941, 1944), and from Chung and Ripperton (1929).

In Hawaii plants representative of the following botanical families serve as hosts of the melon fly: (1) Cucurbitaceae, (2) Solanaceae, (3) Leguminosae, (4) Passifloraceae, (5) Malvaceae, (6) Anacardiaceae, (7) Lauraceae, (8) Caricaceae, (9) Rosaceae, (10) Rutaceae, (11) Moraceae, and (12) Cruciferae. However, the preferred hosts are the cucurbits and tomato. All the cultivated cucurbits are severely attacked, and only one, the chayote (*Sechium edule* Swartz.), is able to resist the attack successfully. There are very few records of the successful rearing of melon fly from chayote, although the female fly frequently punctures and usually lays eggs in the fruit. The eggs may hatch but the larvae fail to complete their development.

Many types of squashes and gourds are grown in Hawaii, and the literature on the melon fly hosts refers to them only by their common names. The squashes are mostly of the two species, *Cucurbita maxima* Duchesne and *C. moschata* Duchesne. Among the gourds there are the white-flowered gourd (*Lagenaria siceraria* [Molina] Standl.), the dish-cloth gourds (*Luffa acutangula* [L.] Roxb. and *L. cylindrica* Roem.), and the snake gourd (*Trichosanthes anguina* L.). There are undoubtedly other species that have been grown in Hawaii and found susceptible to melon fly infestation.

The beans, especially string bean and cowpea, are apt to be attacked when there is an abundance of melon flies in the vicinity. The lima bean was never found infested by Back and Pemberton (1917), but in 1946 several bean pods that had been collected (by Y. T.) from the King's Daughters Home at Waialae, Honolulu, were found infested with melon fly. The infested pods were firm and slightly purplish at the site of oviposition punctures. From 12 pods about 50 adults were reared. Lucas (1941) has reported rearing the melon fly from hyacinth bean (*Dolichos Lablab* L.).

Okra has been found (by O.C.M.) to be a host of the melon fly. In 1945, 16 melon flies emerged from 1 okra pod picked from the garden of the Pineapple Research Institute at the University of Hawaii. Melon flies also oviposited in stems of okra plants that were about 3 feet tall and growing on the University Farm.

In 1930 Fleury reported that the puparia of the melon fly were found by the California Plant Quarantine Service in cucumber and dry onions from Hawaii. We question whether onion is a host of the melon fly.

Pepper, kohlrabi, and cabbage were reported by Back and Pemberton (1917, 1918) as erroneously recorded host plants. They have been reported from Hawaii previously as follows: pepper and cabbage were reported as hosts by Fullaway in 1914; however, in 1915 he thought it was an abnormal condition in the cabbage plant that resulted in attack by melon fly and considered such attack as of a secondary nature; Severin *et al.* (1914) included kohlrabi in their list of host plants. One of the present authors (Y.T.) has reared the melon fly from both pepper and kohlrabi.

The melon fly was reared in 1946 from six varieties of bell pepper (Calwonder Early, Waialua, Large Early Neapolitan, Okamura M, Fordhook, and Manatu Wonder) which were growing on the farm of the University of Hawaii Agricultural Experiment Station. The infestation was rather severe, and many infested fruits dropped prematurely. The symptoms of the infested fruits were like those on tomato—an initial discolored, water-soaked streak and later collapse of the fruit into a soft, soggy mass.

The infested kohlrabi was collected in March 1945 from a garden of the Central Union Church on Beretania St., Honolulu. The stems when collected were firm and had several deep cracks extending from the bases of the leaves part way down the sides of the enlarged portion. The condition was unlike the soft rot which is usually found in tomato and cucurbits. From 3 fully enlarged stems of kohlrabi, 31 melon flies and 6 scavenger flies, *Atherigona excisa* (Thomson), emerged.

In the fall of 1945 a cauliflower plant which was infested with melon fly was found (by O.C.M.). It was wilted and had several punctures on the stem just below the head. At the site of the punctures soft rot had begun to develop. When the stem was cut open, several larvae were found and from them two adults were reared. In 1946 a grower reported that the melon fly was infesting his cauliflower, but the report was not confirmed.

Two growers, who were farming at Koko Head, Oahu, reported that broccoli was being infested by the melon fly. In the field of one of the farmers we saw several plants which, according to the farmer, had been infested by maggots of the melon fly. The infestation was old and no maggot was present at the time. Both farmers were university graduates, and since they were familiar with the melon fly, their report of broccoli as a host of melon fly is probably authentic. Another grower who was farming at Waialua, Oahu, also reported that the melon fly was infesting his broccoli.

Hardy (1949) reared the melon fly from samples of kai choy, a leaf-mustard cabbage (*Brassica juncea* [L.] Cosson), obtained from Hilo, Hawaii. He reported that the assistant county agent found the infestation in kai choy rather general in the Hilo area, and that there was severe damage in some fields.

The fruit crops, in contrast to the vegetable crops, are rarely attacked by the melon fly. Such fruits as waterlemon (passion

fruit), orange, fig, papaya, peach, and mango have been reported as hosts by various sources (Van Dine 1906, 1908; Ehrhorn 1910; Severin *et al.* 1914; Back and Pemberton 1918; Strong 1937; Nishida 1949). The melon fly has been reared from avocado and mango (by O.C.M.). In 1946, from 19 avocado fruits that had ripened on the tree, 5 melon flies emerged. The mango varieties, Common or Manini, French, Fairchild, and Pirie, have been found infested. From 31 fruits of the Common variety 10 flies emerged; from 20 fruits of the French variety 2 flies; from 20 fruits of the Fairchild variety 10 flies; and from 22 fruits of the Pirie variety 1 fly.

Under laboratory conditions the melon fly has been bred frequently in ripe papaya (O.C.M.). In the field C. B. Keck[3] observed a melon fly ovipositing in a small ripe papaya at Kailua, Oahu, on August 28, 1946. The fruit was placed in a cage over sand, and 55 melon flies were reared.

There are three additional fruit crops, tangerine (*Citrus reticulata* Blanco), longan (*Euphoria Longan* [Lour.] Steud.), and Bluefield banana (*Musa paradisiaca* L. ssp. *sapientum* [L.] Ktze.), from which Miss Mabel Chong[3] of the Territorial Board of Agriculture and Forestry has reared the melon fly. Since she obtained only 1 or 2 melon flies from each type of fruit, these hosts have been placed in the category of doubtful hosts until they are confirmed by further records. From 10 fruits of tangerine, which were collected in Honolulu (Punahou) on April 22, 1947, there were 259 oriental fruit flies (*Dacus dorsalis* Hendel) and 1 melon fly; from 94 fruits of longan collected in Honolulu (Nuuanu) on July 14, 1947, were 10 oriental fruit flies and 2 melon flies; from 11 fruits of Bluefield banana collected in Kaneohe, Oahu, on August 25, 1947, were 1 oriental fruit fly and 1 melon fly.

Within susceptible host plants there are certain varieties that are resistant to the melon fly. Fernando and Udurawana (1941) found some strains of bittergourd, *Momordica Charantia* L., to be more resistant than others. They found that four Central Division strains were more resistant than a North-Western Division strain. The Central Division strains were not significantly different from one another. The strain green rough, however, was consistently the best in regard to resistance to the melon fly and also in crop yield. Krauss (1905) reported that, among four varieties of squash, Hubbard was more resistant than Summer Crook Neck, Scallop, and Gold o'Heart.

Some varieties of tomato show marked resistance to melon fly. In 1904 Smith noted that some varieties of tomato in Hawaii were resistant, but he did not identify these varieties. In 1919 Higgins reported that a small-fruited wild variety growing in Hawaii appeared to be immune, and that the "pear" and "plum" varieties were also resistant. He believed that resistance in tomato

[3] Unpublished note.

was due to a combination of slipperiness and toughness of the skin and to certain characters concerning the shape of the fruit. The offspring of crosses between resistant varieties and susceptible commercial varieties was less susceptible (Higgins 1919; Pope 1924, 1925). Sumida *et al.* (1943) reported that a wild cherry tomato, the Hawaiian Cherry, was apparently resistant. This variety is apparently the one referred to by Higgins in 1919. Back and Pemberton (1917, 1918) reported that they had never found the melon fly attacking the fruits of currant tomato (*Solanum pimpinellifolium* [also known by present-day botanists as *Lycopersicon esculentum* Mill. subsp. *Galeni* (Mill.) Luckwill (*L. esculentum* var. *cerasiforme*)], grape tomato (*S. lycopersicon* [also known as *Lycopersicon esculentum* Mill.]), popolo (*Solanum nodiflorum* Jacq.), and a spiny yellow-fruited *Solanum*.

While working with two varieties of tomato, Marlowe (1937) found that the average infestation by the melon fly was 19.3 per cent for the Break O'Day variety, and 59.3 per cent for the Pritchard variety. The average yield of marketable fruits of Break O'Day was eight times that of Pritchard.

In 1917 Back and Pemberton reported that most varieties of bean were seldom attacked by the melon fly and only the fleshy, long-podded Chinese variety was susceptible to infestation. They also noted distinct differences in susceptibility among varieties of cowpea. In 1919 Higgins reported that J. H. Cowan tested the susceptibility of 16 varieties of bean to the melon fly. Cowan found that the varieties Early Refugee and Refugee Wax were not infested by the fly, the varieties Stringless Refugee (not wax) and the Ventura Wonder Wax had less than 1 per cent injury, and the varieties Stringless Green Pod and Black Valentine, which were most heavily attacked, had infestations of 21.1 and 16 per cent, respectively. Holdaway (1940) also noticed a difference in susceptibility among three varieties of string bean. The variety Lualualei exhibited the highest percentage of attack, McCaslan the next, and Kentucky Wonder the lowest. He stated that a bush green-podded type of bean, Tendergreen, was observed by the grower to be the most heavily attacked of all.

Table 1.—Host plants of the melon fly recorded in Hawaii

HOST PLANT	REFERENCE
Plants Frequently Injured	
Cucurbitaceae:	
Cantaloupe or muskmelon (*Cucumis Melo* L.)[4]	Van Dine 1906, 1908; Severin *et al.* 1914; Back and Pemberton 1917, 1918.
Gourds (*Lagenaria siceraria* [Molina] Standl. [Syn. *L. leucantha* and *L. vulgaris*]; *Luffa cylindrica* Roem.; *Luffa acutangula*]L.[Roxb.; *Trichosanthes anguina* L.)	
Chinese cucumber, *Momordica* sp. (Balsam-pear, *Momordica Charantia* L.)	Back and Pemberton 1917, 1918.
Chinese melon (Chinese preserving melon, *Benincasa hispida* [Thunb.] Cogn. [Syn. *B. cerifera*]; oriental pickling melon, *Cucumis Melo* var. *Conomon* [Thunb.] Makino)	
Squash (*Cucurbita maxima* Duchesne; *C. moschata* Duchesne)	
Cucumber (*Cucumis sativus* L.)	
Pumpkin (*Cucurbita Pepo* L.)	Van Dine 1906, 1908; Severin *et al.* 1914; Back and Pemberton 1917, 1918.
Watermelon (*Citrullus vulgaris* Schrad.)	
Solanaceae:	
Tomato (*Lycopersicon esculentum* Mill.)	
Plants Occasionally Injured	
Leguminosae:	
String bean (*Phaseolus vulgaris* L.)[5]	Van Dine 1906, 1908; Severin *et al.* 1914; Back and Pemberton 1917, 1918.
Cowpea (*Vigna sinensis* [L.] Savi)	Back and Pemberton 1917, 1918.
Hyacinth bean, *Dolichos Lablab* L.	Lucas 1941.
Lima bean, *Phaseolus limensis* Macf.	Tanada.[6]
Solanaceae:	
Green pepper (*Capsicum frutescens* L. var. *grossum* [L.] Bailey)[5]	Fullaway 1914; Maskew 1919; Tanada.[6]
Eggplant (*Solanum Melongena* L.)	Fullaway 1914; Severin *et al.* 1914; Back and Pemberton 1917, 1918.

[4] Names in parentheses have been inserted by the authors.
[5] Occasionally heavy infestation occurs in favorable localities.

Table 1.—Continued

HOST PLANT	REFERENCE
Plants Rarely Injured	
Anacardiaceae:	
Mango (*Mangifera indica* L.)	Van Dine 1906, 1908; Severin *et al.* 1914; Back and Pemberton 1917, 1918.
Caricaceae:	
Papaya (*Carica Papaya* L.)	Van Dine 1906, 1908; Severin *et al.* 1914; Back and Pemberton 1917, 1918; Strong 1937.
Cruciferae:	
Kohlrabi (*Brassica caulorapa* [DC.] Pasq.)	Severin *et al.* 1914; Tanada.[6]
Cauliflower, *Brassica oleracea* var. *botrytis* L.	McBride.[6]
Leaf-mustard cabbage, *Brassica juncea* (L.) Cosson	Hardy 1949.
Cucurbitaceae:	
Chayote (*Sechium édule* Swartz)	Back and Pemberton 1918.
Lauraceae:	
Avocado, *Persea americana* Mill. [Syn. *P. gratissima*]	McBride.[6]
Leguminosae:	
Pigeon pea (*Cajanus Cajan* [L.] Millsp.)	Foreign Plant Quarantine Interception Files 12014, 1946.[6]
Malvaceae:	
Okra, *Hibiscus esculentus* L.	McBride.[6]
Moraceae:	
Fig (*Ficus Carica* L.)	Back and Pemberton 1917, 1918.
Passifloraceae:	
Waterlemon, *Passiflora* sp.	Back and Pemberton 1917, 1918.
Passiflora Seemanni Griseb.	Nishida 1949
Rosaceae:	
Peach (*Prunus Persica* [L.] Batsch)	Back and Pemberton 1917, 1918.
Rutaceae:	
Orange (*Citrus sinensis* [L.] Osbeck)	Ehrhorn 1910; Severin *et al.* 1914; Back and Pemberton 1917, 1918.
Wild Hosts	
Cucurbitaceae:	
Momordica sp. (Balsam-apple, *Momordica Balsamina* L.)	Back and Pemberton 1917, 1918.
Sycos sp. (*Sicyos* ?)	Van Dine 1906, 1908; Severin *et al.* 1914; Back and Pemberton 1917, 1918.

[6] Unpublished.

Table 1.—Continued

HOST PLANT	REFERENCE
Doubtful Hosts	
Cruciferae:	
Broccoli, *Brassica oleracea* L. var. *botrytis* L.	Report of three farmers.
Cabbage (*Brassica oleracea* L. var. *capitata* L.)	Fullaway 1914, 1915.
Liliaceae:	
Dry onion (*Allium Cepa* L.)	Fleury 1930.
Musaceae:	
Bluefield banana, *Musa paradisiaca* L. ssp. *sapientum* (L.) Ktze.	Chong.[6]
Rutaceae:	
Tangerine, *Citrus reticulata* Blanco	Chong.[6]
Sapindaceae:	
Longan, *Euphoria Longan* (Lour.) Steud.	Chong.[6]

Table 2.—Plants which have not been recorded in Hawaii as hosts of the melon fly, but which have been reported as such in other localities

HOST PLANT	COUNTRY	REFERENCE
Cucurbitaceae:		
Bryonopsis laciniosa (L.) Naud.	Formosa	Shiraki 1933.
Citrullus sp.	Java	Back and Pemberton 1917, 1918.
Cucumis sp.	India; Burma	Fletcher 1917.
Dondakaya or kovaikkai, *Coccinia indica* Wight and Arn. (*C. cordifolia* [L.] Cogn.)[7]	India	Cherian and Sundaram 1939.
Luffa spp.	Philippines; India	Woodworth 1922 (II); Pruthi 1937.
Melothria heterophylla Cogn.	Formosa	Shiraki 1933.
Parya-soorten, Momordica sp.	Java	Franssen 1937.
Trichosanthes cucumerina L.	India; Burma	Fletcher 1917.
Trichosanthes cucumeroides Maxim.	Formosa	Shiraki 1933.
Trichosanthes dioica Roxb.	India; Burma	Fletcher 1917.
Leguminosae: *Mungos or green gram, *Phaseolus radiatus* L. *Vigna* spp.: cowpea, sitao, **Vigna sesquipedalis* (Koern.) Wight, etc.	Philippines	Woodworth 1921 (I).
Annonaceae: *Annonas or custard-apple (*Annona reticulata* L.) *Ates or sugar-apple (*Annona squamosa* L.) *Guanabanos or soursop (*Annona muricata* L.)	Philippines	Woodworth 1922 (III); Ponce 1937.
Myrtaceae:		
*Guava, *Psidium Guajava* L.	Philippines; India	Woodworth 1922 (III); Chopra 1928; Ponce 1937.
Palmae:		
*Date (*Phoenix dactylifera* L.)	India	Chopra 1928.
Passifloraceae: *Granadilla, *Passiflora quadrangularis* L. *Passion flower, *Passiflora edulis* Sims. *Passion flower, *Passiflora foetida* L.	Philippines	Woodworth 1921 (I).
Rosaceae: *Apple (*Pyrus Malus* L.) *Pear (*Pyrus communis* L.) *Strawberry (*Fragaria chiloensis* [L.] Duchesne)	Japan[8]	Fukai 1938.
Rutaceae:		
Citrus (*Citrus* spp.)	India; Japan[8]	Husain 1929; Fukai 1938.

* Plants found in Hawaii also.
[7] Names in parentheses have been inserted by the authors.
[8] Probably not field infestation.

Summary

A list of host plants of the melon fly (*Dacus cucurbitae* Coq.) in Hawaii has been compiled. The list includes approximately 36 plants belonging to 12 botanical families. Four of these plants—lima bean (*Phaseolus limensis* Macf.), avocado (*Persea americana* Mill.), okra (*Hibiscus esculentus* L.), and cauliflower (*Brassica oleracea* L. var. *botrytis* L.)—are here reported for the first time as hosts of the melon fly. Pepper (*Capsicum frutescens* L. var. *grossum* [L.] Bailey) and kohlrabi (*Brassica caulorapa* [DC.] Pasq.), have been previously considered as erroneously recorded hosts, but because they have been found infested by the melon fly, they must be regarded as hosts. Six plants have been placed in the category of doubtful hosts until they are confirmed by further records.

The most susceptible hosts of the melon fly are the cucurbits and tomato. The host plants have been divided into five groups. The plants in the first three groups are separated on the basis of the frequency of injury under general field conditions. Wild and doubtful hosts make up the other two groups.

Host plants reported from other countries, but which have not yet been found infested in Hawaii, are also listed.

Certain varieties of bittergourd, squash, tomato, string bean, and cowpea have been reported to be much more resistant to infestation by the melon fly than other varieties of these species.

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The Muscid Genus Ophyra in the Pacific Region (Diptera)

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(Presented by Mr. Tanada at the meeting of April 12, 1948)

The scavenger flies of the genus *Ophyra* R. D. are common, and the species are widely distributed, probably because they breed in decaying vegetation, carrion, or manure. Because of the close resemblance of the species, misidentifications can easily occur, especially when only female specimens are available. It has therefore seemed desirable to review the species of the Pacific region, and to make available a key for their determination. The synopsis by Malloch (1923, Annals & Mag. Nat. Hist., [9], **11**: 664-666) is a sound basis for the study of the genus, and the following key is essentially a modification and enlargement of his work. As accepted here, the genus is a combination of *Ophyra* and *Peronia* as defined by Séguy (1937, Genera Insectorum).

Bryan (1934, Proc. Hawaii. Ent. Soc. **8**: 425, 453) stated that *Ophyra nigra* and *O. chalcogaster* were of general distribution in the Hawaiian Islands, and that *O. aenescens* and *O. leucostoma* probably did not occur there, even though they had been recorded in older literature. I have not seen *nigra* from Hawaii, but *aenescens* has been received for determination several times. Yoshinori Tanada informs me that *aenescens* is the species that has thus far been known in Hawaii as *nigra*. Most of the misidentifications in the genus appear to center about the latter, for I have seen five different species identified under that name.

Although only two species, *chalcogaster* and *aenescens*, are definitely known to me to occur in Hawaii, several others may at any time be found there. The following key has therefore been framed to include all species known to occur anywhere in the Pacific area, together with *O. capensis* which is introduced for comparison with a new species. Two species described by Stein, *hirtitibia* from Java and *simplex* from Formosa, are included in the key to males only on the basis of Stein's descriptions.

The figures have been selected to show sufficient variety in the important characters, so that one can compare other species and better realize the modifications in the several species.

KEY TO THE SPECIES OF OPHYRA OF THE PACIFIC REGION

Males

1. Habitus like a small *Calliphora*, the thorax dull black and abdomen dark metallic blue with whitish pollen, especially on apical segment; frontal lunule not silvery pollinose (*Australophyra*).. **O. rostrata** (R. D.)
O. analis Macq.

Not so; the thorax and abdomen concolorous, dull black to shining black, abdomen at most with an obscure, fine pollen or bloom...... 2.

Proc. Hawn. Ent. Soc., Vol. XIII, No. 3, March, 1949.

2. Palpus yellow or reddish yellow; hind tibia posteroventrally without either bristles or long setaceous hairs, and anteroventrally with only two or three short bristles (fig. 7); both mid and hind femora with some short, stout, erect spines on the ventral surface near the base..**O. aenescens** (Wd.) (p. 427)
   Palpus black; hind tibia posteroventrally with some to many long setaceous hairs, except in *simplex*.. 3.

3. Hind tibia strongly arched beyond the basal third, and densely clothed with long hairs both antero- and posteroventrally; both mid and hind femora with short spines ventrally near the base, hind femur usually with only one spine, mid femur with two irregular rows (fig. 4)..**O. leucostoma** (Wd.) (p. 428)
   Hind tibia straight or only gently curved.. 4.

4. Middle femur ventrally near the base with 2-3 short, erect, stout, black spines or spinelike bristles (fig. 5); posterior margin of eye, as viewed in profile, distinctly emarginate (fig. 2).. 5.
   Middle femur without such spines, at most with only fine, slender, erect hairs ventrally near the base (fig. 6); posterior margin of eye not emarginate in *chalcogaster* (fig. 3), but unknown to me for *hirtitibia* and *simplex*.. 7.

5. Mesonotum anterior to suture densely and uniformly covered with long, erect, fine hairs, the dorsocentral and acrostichal bristles weak and scarcely differentiated from hairs; hind femur ventrally near base with an erect but weak, slender, and inconspicuous hair........ 6.
   Mesonotum not densely and uniformly haired, with bare stripes between the median group of hairs and each row of dorsocentral bristles; hairs short, dorsocentral bristles strong and conspicuous; hind femur ventrally near base with one, sometimes two, short stout spinelike bristles..**O. nigra** (Wd.) (p. 428)

6. Parafrontal and upper part of parafacial glabrous and polished black..**O. capensis** (Wd.) (p. ....)
   Parafrontal and upper part of parafacial gray to brownish pollinose..**O. obscurifrons** Sabr. (p. 430)

7. Hind femur ventrally near base with one row, and a partial second, of short stout spines; segments of fore tarsus with yellow to whitish apices, the pale area most extensive ventrally..
   ....**O. chalcogaster** (Wd.) (p. 431)
   Hind femur without spines ventrally near base; fore tarsus black.. 8.

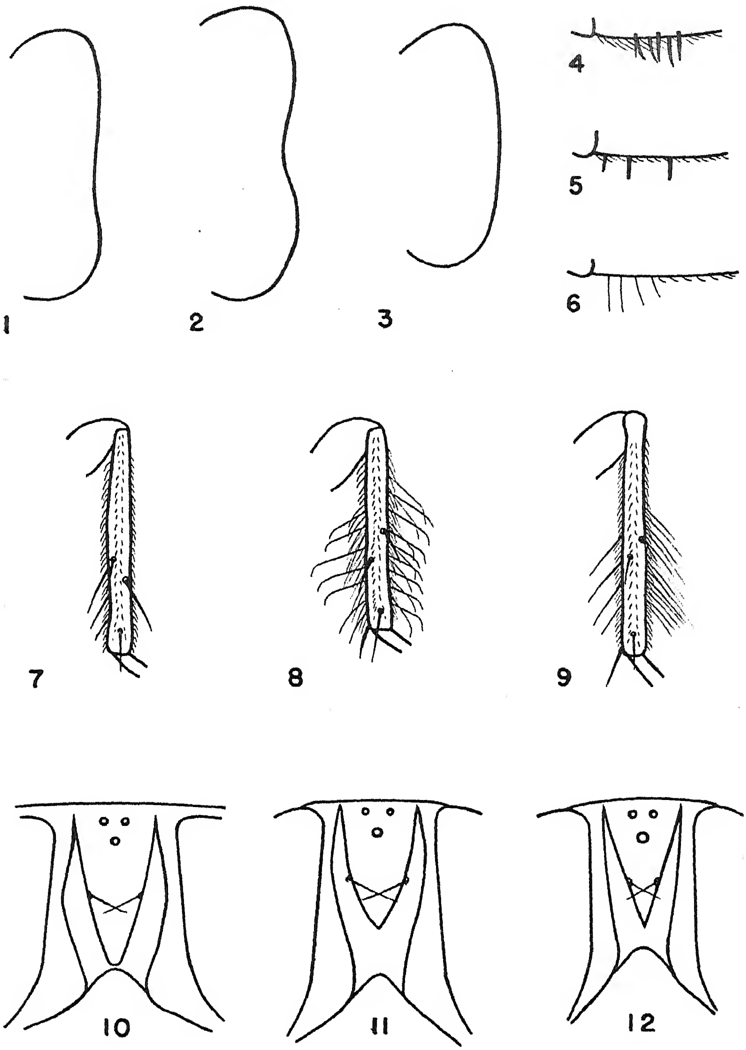
8. Hind tibia both antero- and posteroventrally with long setaceous hairs; antenna of normal length, not elongate as in *simplex*........
   ....**O. hirtitibia** Stein
   Hind tibia without long setaceous hairs, with only a few short bristles; antenna elongate, the apex almost opposite the lower margin of an eye..**O. simplex** Stein

Females

(Unknown, or the characters not known, for *hirtitibia* and *simplex*)

1. Species with blue abdomen and black thorax (see key to males)
   ....**O. rostrata** (R.D.) and **O. analis** Macq.
   Thorax and abdomen concolorous .... 2.

2. Palpus yellow; frontal triangle elongate, extending the full length of the front up to the lunule, apically subtruncate or broadly rounded (fig. 10)..**O. aenescens** (Wd.) (p. 427)
   Palpus black; frontal triangle short, ending well before the lunule, or if longer, the apex is acute (figs. 11, 12).. 3.



Characters of *Ophyra* species

Figs. 1-3, posterior margin of eye, in side view; figs. 4-6, profile of the ventral surface of middle femur of male, toward the base; figs. 7-9, outer aspect of left hind tibia of male, the anterior bristles (anterodorsal and anteroventral) projecting toward the left, the posterior toward the right; figs. 10-12, proportions of the front and frontal triangle of the female.

Figs. 1, 7, and 10, **Ophyra aenescens**; figs. 2, 5, and 11, **O. nigra**; figs. 3, 6, 9, and 12, **O. chalcogaster**; fig. 4, **O. leucostoma**; fig. 8, **O. obscurifrons**.

3. Mesonotum anterior to the suture densely and uniformly covered with long, erect, fine hairs, the dorsocentral and acrostichal bristles weak and scarcely differentiated from hairs; frontal triangle long and broad, the apex attaining the anterior margin of the front, or nearly so .... 4.
   Mesonotum not densely and uniformly covered with long hairs, the hairs short, relatively sparse, and usually with definite bare areas between the median group of hairs and each dorsocentral position, the dorsocentral bristles distinctly developed; frontal triangle short and broad, or if long, it is notably more slender than the above .... 5.

4. Frontal triangle, parafrontal, and upper part of the parafacial glabrous and polished black .... **O. capensis** (Wd.) (p. 429)
   The above portions of the head gray to brownish pollinose .... **O. obscurifrons** Sabr. (p. 430)

5. Frontal triangle broad, its width at the level of the cruciate interfrontal bristles three times the width of the parafrontal directly opposite, the sides of the triangle convex (fig. 11); posterior margin of the eye as seen in profile conspicuously emarginate (fig. 2) .... **O. nigra** (Wd.) (p. 428)
   Frontal triangle slender, its width at the interfrontal level usually about twice the width of the parafrontal directly opposite, the sides of the triangle straight, or nearly so (fig. 12); posterior margin of the eye not emarginate (fig. 3), or at most only gently concave over its entire length .... 6.

6. Arista entirely black; fore tarsus black; hind tibia with two or more anteroventral bristles .... **O. leucostoma** (Wd.) (p. 428)
   Arista yellow basally; fore tarsal segments with whitish-yellow apices; hind tibia typically with only one anteroventral bristle, occasionally with two or three .... **O. chalcogaster** (Wd.) (p. 431)

SPECIES OF THE PACIFIC REGION NOT INCLUDED IN THE KEY

Ophyra spinigera Stein (1910, Ann. Mus. Nat. Hung. **8**: 555), based on a single male from Singapore, may equal *O. nigra* as Malloch has suggested. Certainly the chaetotaxy of the legs sounds like *nigra*, but Stein's description of the thorax as almost entirely naked, and the acrostichal bristles entirely lacking, suggests the possibility that some other species was actually involved. Only a careful study of the holotype can settle this question.

Ophyra gracilis (Wiedemann) (Auss. Zweifl. Ins., 2: 432), from China, has not been identified.

It may also be noted here that *Ophyra hirtitarsis* Stein (1907, Ann. Mus. Zool. Acad. Sci. St. Petersbourg **12**: 335), described from a single male from northeastern Tibet, runs to *nigra* on the basis of Stein's description, but insufficient critical details are given there to place it more definitely. Stein wrote that the orbits are silver gray pollinose, which would suggest *obscurifrons*, but his further statement that the acrostichals are strong and in two rows shows that *hirtitarsis* is something quite different.

The Status of Australophyra Malloch

Australophyra Malloch, 1923, Annals & Mag. Nat. Hist., (9), **11**: 667. Type, *Ophyra analis* Macq.

Peronia Robineau-Desvoidy, 1830, Essai sur les Myodaires, p. 517. Type, *P. rostrata* R. D.

Hardy (1939, Proc. Roy. Soc. Queensland **50**: 38) placed *Peronia* R. D. (= *Australophyra* Mall.) as a synonym of *Ophyra*, on the ground that the distinctions on which the former were based are too weak and variable for generic separation. Certainly the species closely resemble *Ophyra*, though lacking the silvery lunule commonly associated with the genus, and the relation is evident when such a species as *O. obscurifrons* is considered. I agree with Hardy in the synonymy. If *Peronia* is segregated from *Ophyra*, however, as may be done by some authors, *Australophyra* should be used in preference to *Peronia*, for the latter is preoccupied by *Peronia* Fleming (1822) in the Mollusca. This fact was not noticed by Malloch when he sank his genus as a synonym of *Peronia* (1926, Proc. Linn. N. S. Wales **51**: 554), nor by Hardy.

Ophyra rostrata (R. D.) and *O. analis* Macq., which are regarded by Hardy as separate species, are the only known species in the group.

Ophyra aenescens (Wd.)

Anthomyia aenescens Wiedemann, 1830, Auss. Zweifl. Ins., **2**: 435. (Louisiana.)

Ophyra trochanterata Malloch, 1932, Bishop Mus. Bul. **98**: 196 (Marquesas, Tahiti). New synonym.

As the only known species of the genus with yellow palpi, it is easily distinguished by that feature in both sexes. The males are also distinctive in having a dense tuft of long hairs on the ventral surface of the hind trochanter, and in completely lacking any long setaceous hairs on the hind tibia (fig. 7). The posterior margin of the eye as seen in profile is only gently emarginate (fig. 1).

It has been considered that *aenescens* occurs only in the Americas and in southern Europe. It was recorded from the Hawaiian Islands by Grimshaw (1901, Fauna Hawaiiensis, **3**, pt. 1: 30), and again by Illingworth (1923, Proc. Hawaiian Ent. Soc. **5**: 277), but Bryan has stated that it "may not occur in Hawaii" (1934, Proc. Hawaiian Ent. Soc. **8**: 425). The material that I have studied recently, however, indicates that it is found in Hawaii and in a number of the islands of the eastern Pacific.

(1) The Galapagos' *Ophyra* with yellow palpi (*Anthomyia setia* Walker) is definitely *aenescens*, as already recognized by Aldrich and Curran.

(2) Malloch's detailed description of *trochanterata* fits typical

aenescens exactly. A long series of paratypes of the former was available for direct comparison.

(3) I have seen a number of specimens of *aenescens* from the Hawaiian Islands, including eight from Mt. Tantalus, Oahu, May 19 and June 3, 1939, the latter bred from rotten meat by Mr. Tanada.

(4) In the U. S. National Museum collection are two females of *aenescens,* collected on Nauru and Ocean Islands, just west of the Gilbert Islands, in June, 1908 (F. W. Steel), and previously determined by some author as *O. nigra.* This appears to be the westernmost record of *aenescens* up to the present time.

Ophyra leucostoma (Wd.)

Anthomyia leucostoma Wiedemann, 1817, Zool. Mag. **1**: 82.

This common North American and European species was recorded from Hawaii by Grimshaw (1901, op. cit., p. 30) and Howard (1901, Proc. Ent. Soc. Wash. 4: 490), but the identifications were probably incorrect.[1] If correct, the species does not appear to have become established in the islands. The strongly bowed hind tibia of the male is unique in the genus, but the females are difficult to separate from other species. The appearance of the front and frontal triangle in the female sex is similar to that of *O. nigra* (cf. fig. 11), but the deeply emarginate eye of *nigra* fortunately is so distinctly different from *leucostoma* that these two should not be confused.

In the collection before me is a male from Japan, and another from Suifu, Szechuen, China (D. C. Graham), which are typical *leucostoma.*

Ophyra nigra (Wd.)

Anthomyia nigra Wiedemann, 1830, Auss. Zweifl. Ins. **2**: 432 (China).

Ophyra nigra (Wd.); Stein, 1910, Ann. Mus. Nat. Hung. **8**: 555, notes on type; Malloch, 1923, Annals & Mag. Nat. Hist., (9), **11**: 664-666.

It is possible that more than one species is really involved and that it should be referred to here as the "*nigra* complex." In males from China, the hind tibia has a row of 3-5 short, well-spaced bristles anteroventrally (as in fig. 9, but shorter), whereas South Pacific and Australian specimens generally have more and longer setaceous hairs on the anteroventral surface, sometimes approaching a densely bushy appearance. There are some intermediates, however, and the evidence is not conclusive. As recognized here, *Ophyra nigra* is a wide-ranging and common species represented

[1] Howard's record was based on four specimens collected in Hawaii by H. W. Henshaw. In the National Museum Collection, there are now ten specimens which were collected by Henshaw in Hawaii on various dates in 1900, and all of these are *Ophyra chalcogaster.*

in the collection by material ranging from China and Japan through many of the western Pacific Islands to Australia.

The deeply emarginate eye (fig. 2) is one of the most distinctive features, and one that will easily distinguish both sexes from *O. chalcogaster*, with which it has been frequently confused. Likewise, the short, broad frontal triangle of the female of *nigra* (fig. 11) will distinguish that sex from the other species of *Ophyra* in the Pacific, as far as known to me.

Specimens of *nigra* before me are from China (Ningyuenfu, Chihli, Szechuen), Japan, Vladivostok, Okinawa, Yap, Guam, Ponape, Bismarck Archipelago, the Solomons, the New Hebrides, Queensland (Brisbane, Cairns), and Northern Territory (Darwin).

Hardy (1939, l.c., p. 38) has identified a species from Queensland and New South Wales as *Ophyra fuscocalyptrata* (Macq.), and his species is undoubtedly what I have called *nigra* (see following discussion).

Hydrotaea fusco-calyptrata Macq.

Hydrotaea fusco-calyptrata Macquart, 1855, Dipt. Exot., suppl. **5**: 139 (Australia).

Hydrotaea fuscocalyptrata (Macq.); Stein, 1907, Ztschr. Hym. Dipt. **7**: 275. Notes on holotype.

Ophyra fuscocalyptrata (Macq.): Hardy, 1939, Proc. Roy. Soc. Queensland **50**: 38.

The status of this specific name is of interest in connection with the identity and distribution of *Ophyra nigra* (Wied.).

Hardy has referred Macquart's species to *Ophyra*, and has used the name to replace "*Ophyra nigra* of authors, at least in part," presumably for the Australian form. Macquart's original description, however, mentioned the spine on the fore femur, a characteristic of male *Hydrotaea*. The silvery lunule noted by Macquart, which has apparently influenced the reference to *Ophyra*, is indeed conspicuous in typical *Ophyra*, but it is also present in many *Hydrotaea*. Stein (1907) examined the type, and since that leading specialist in the muscid flies saw no reason to change the species from *Hydrotaea*, I believe that it should be left there.

Ophyra capensis (Wd.)

Anthomyia capensis Wiedemann, 1818, Zool. Mag. **1** (pt. 2): 46 (Cape Colony); 1830, Auss. Zweifl. Ins., **2**: 426.

Anthomyia anthrax Meigen, 1826, Syst. Beschr. **5**: 161 (Europe).

(? Synonym) *Ophyra villosa* Aldrich, 1928, Proc. U. S. Nat. Mus. **74** (Art. 1): 6 (Chile).

This species has commonly been called *anthrax*, apparently because *capensis* was considered to date from 1830. The priority of *capensis* Wiedemann (1818) has recently been recognized by several authors.

True *capensis* may not occur in the Oriental Region (cf. *obscurifrons*, new species), but for the purpose of comparison, the following description is given, based on a series of specimens from Germany:

Male: Shining bluish black or greenish black, with black palpi and white calypteres; posterior margin of the eye as viewed in profile distinctly emarginate; parafrontal and upper third to half of the parafacial glabrous and polished black, highly shining; mesonotum densely and uniformly covered with fine, erect hairs, the presutural dorsocentral and acrostichal bristles scarcely distinguishable, only slightly longer and stronger than the surrounding hairs; middle femur with one or more, typically two, short, straight, spinelike bristles on the mid-ventral surface near the base, but the hind femur with only fine hairs in the corresponding position; hind tibia with rather short and inconspicuous anterodorsal and posterodorsal bristles (one of each) about midway of the tibia, and ventrally with numerous conspicuously long, setaceous hairs, including one row of eight on the anteroventral surface and several rows on the posteroventral, all projecting nearly at right angles to the tibia and curling slightly at the ends (as in fig. 8, of *obscurifrons*).

Female: As described for the male, except as follows: front broad, the frontal triangle glabrous and polished like the parafrontal, long and ending acutely close to the lunule, the width of the triangle at the level of the cruciate interfrontal bristles obviously wider than from the triangle to an eye opposite that point; both mid and hind femora with fine hairs on the ventral surface toward the base; hind tibia with two posterodorsal bristles, and ventrally with a row of three to five anteroventral bristles, the longest of which are only slightly longer than the diameter of the tibia, but without posteroventral bristles.

Ophyra villosa Aldrich may be a synonym. The type and paratype of *villosa*, and another specimen from the type locality, all males, have been compared in detail with European material of *capensis*, and I can find no differences on which to separate them. Some might be found in the characters of the female sex, and until these are known, I do not care to state the synonymy definitely.

Ophyra obscurifrons, new species

Virtually identical with *O. capensis*, under which it had previously been determined, but distinguished as follows:

Male: parafrontal and parafacial dull or only subshining, not smooth and polished, but entirely gray to brownish pollinose, appearing under high magnification as if covered with a short, fine nap.

Female: Like the male, but the parafrontal viewed in some lights seems rather shining and must be viewed from different angles to be sure that it is entirely pollinose; frontal triangle long and broad, of approximately the same proportion as *capensis*, differing in having the entire surface covered with the same minute brownish nap as the parafrontal, and thus dull or only subshining instead of smooth and polished.

Holotype, male, Tsinan, Shantung, China, May 3, 1922 (A. P. Jacot). Type No. 58675 in the U. S. National Museum. Allotype, Ningpo, China, June 14, 1925 (J. T. Chu). Paratypes, four males, Tsinan, April 13 and 21, May 26, and June 9, 1922 (Jacot); one male, Ningpo, June 22, 1925 (H. A. Jaynes); one male, Suifu, Szechuen, China (D. C. Graham); one male, Kuanshien, Szechuen, China, June 1-14, 1930 (Graham); one male, Okinawa, June 23, 1945 (F. N. Young). Type series in the U. S. National Museum.

All other species of typical *Ophyra* known to me have the parafrontal, the upper third to half of the parafacial, and the frontal triangle in the female, glabrous and highly polished. Only the species formerly placed in *Australophyra* (= *Peronia*), which are rather atypical *Ophyra*, also have the dull, pollinose parafrontal, parafacial, and frontal triangle.

The published records of *capensis* (usually as *anthrax*) from China may actually refer to *obscurifrons*. Typical *leucostoma* has been found in China, however, and true *capensis* may also occur there in addition to the related *obscurifrons*.

Stein (1907) described *hirtitarsis* from Tibet as having "narrow silver gray dusted orbits," possibly like those of *obscurifrons*. The hind tibia of *hirtitarsis* is quite different, however, the bristles being reduced to one long outer and one shorter inner bristle, compared with the rows of long bristles or setaceous hairs in *obscurifrons*. Further, Stein stated that the acrostichals of *hirtitarsis* are rather strong, and in two rows (like those of *chalcogaster*), whereas in *obscurifrons*, as in *capensis*, the notum is thickly and uniformly covered with fine hairs, and the acrostichal bristles are scarcely distinguishable.

Ophyra chalcogaster (Wd.)

Anthomyia chalcogaster Wiedemann, 1824, Analecta Entom., p. 52; 1830, Auss. Zweifl. Ins. 2: 427 (Java).

The best single character for distinguishing this species from the others with black palpi is that the posterior margin of the eye as viewed in profile is straight or slightly convex (fig. 3), though this may sometimes cause confusion with *leucostoma*. The eye profile is certainly the quickest way to distinguish *chalcogaster* from *nigra* (cf. figs. 2 and 3), and these two are the most commonly confused species in the Pacific area.

The character most frequently mentioned in connection with *chalcogaster*, namely, that the segments of the fore tarsi are whitish apically, especially on the ventral surface, can be a very

misleading character and one which should be minimized as a means of recognition. It is true that specimens of *chalcogaster* often have strong, distinct white spots at the apices of the fore tarsal segments, which can sometimes be seen from above, though more clearly from below. There are many specimens of *chalcogaster,* however, in which these spots are less distinct, in varying degrees, and this variation has undoubtedly given rise to many misidentifications.

A number of specimens have been reared from poultry manure at the University of Hawaii Agricultural Experiment Station, Honolulu, by Yoshinori Tanada.

From the published records, the species is widely distributed throughout the Ethiopian, Oriental and Australian Regions. A large number of specimens are before me from the following:

Oriental Region: Ceylon, India (Goa, Coimbatore, Malabar), Cochin China, Penang, China (Szechuen, Nanking, Zakow, Hong Kong, Chihli), Formosa, Okinawa, Philippine Islands (Manila, Mindanao, Samar), Sumatra, Java.

Australian Region: Hawaiian Islands, Marianas (Guam, Saipan), Palaus, Ponape, Dutch New Guinea, Bismarck Archipelago, Solomons, New Hebrides, New Caledonia, Northern Territory (Darwin, Melville Island), and Queensland (Brisbane, Townsville). Most of the Australian specimens were determined as *nigra* by early authors, and redetermined as *chalcogaster* by Malloch.

Observations on the Life History of Pycnoscelus surinamensis (Linn.), the Intermediate Host of the Chicken Eyeworm in Hawaii

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(Presented at the meeting of November 9, 1948)

INTRODUCTION

In beginning a study of the life history of *Oxyspirura mansoni* (Cobbold), the eyeworm of chickens in Hawaii, the author was impressed with the virtual lack of information in the literature concerning the life history and habits of its only known intermediate host, the cockroach, *Pycnoscelus surinamensis* (Linn.). Some observations which have been made on the biology of the roach are herein presented.

SYNONYMY

Blatta surinamensis Linn. (1758 and 1767), *Blatta punctata* Eschscholtz (1822), *Panchlora surinamensis* Guer. (1838), *Pycnoscelus obscurus* Scudd. (1862), *Leucophaea surinamensis* Brunn. (1865), *Blatta indica* Fabr., *Blatta melanocephala* Stoll, *Blatta corticum* Serville, *Panchlora celebesa* Walker, *Panchlora submarginata* Walker, *Panchlora occipitalis* Walker.

DISCUSSION

The Surinam roach is an important insect pest for which no satisfactory biological control yet exists in Hawaii. In certain localities it has become established as a greenhouse pest and has done considerable damage to the bark of roses and lilies. It is also reported to feed upon the roots of the pineapple, the potato tuber, and other plants. It serves as the only known intermediate host of *Oxyspirura mansoni*, a nematode parasite commonly found beneath the nictitating membrane and in the conjunctival sac of domestic fowl and a number of wild birds.

The presence of *Pycnoscelus surinamensis* in the Hawaiian Islands was first reported by Eschscholtz in 1822. Subsequent observations indicate that the roach is widespread, and at the present time it may be found in abundance on Oahu, Kaui, Molokai, Maui, Lanai, Nihoa, Hawaii, Pearl and Hermes Reef, and French Frigate Shoal.

It is thought by some workers to be originally an Oriental species, but today it is considered circumtropical, having been reported from the following localities: Florida, Louisiana, Texas, and Hawaii in the United States; Cuba and Puerto Rico (Rehn, 1903); the Bahama Islands (Morse, 1905, and Hutson, 1938); the Dominican Republic (Caudell, 1914); Trinidad (Bruner, 1906);

Barbados, Martinique, Grenada, St. Vincent, Jamaica, Mexico, Costa Rica, Guiana, and Brazil (North Am. Orthoptera, 1901); Bermuda (Scudder, 1897); Lower Spain, Africa (Senegal), China (Amoy), and the Philippine Islands (North Am. Orthoptera, 1901); Singapore (Ehrhorn, 1916); Java, Sumatra and the Dutch East Indies (Picard, 1929); Japan and Formosa (Kobayashi, 1927); and Australia (Fielding, 1926).

The normal habitat of the roach in Hawaii is in loose, sandy soil, or beneath trash and debris. It is found most commonly in or around chicken batteries and yards, where it subsists chiefly on chicken feces and other organic matter. The soil is literally teeming with the nymphs and adult roachs in such places, and all stages may be readily collected for study. They mostly remain hidden in the soil during the daylight hours, coming out on the surface to feed only at night. The younger nymphs are not nearly so averse to the light as the adults and larger nymphs; in fact, newborn nymphs in the laboratory exhibited a marked positive phototropism during the first several days of life.

When molested in the soil, the nymphs are considerably more active than the adults; all, however, rapidly seek cover. In random collections of adults the females were always found to be more abundant than the males, an observation which verifies the findings of Hebard (1917) and Zappe (1918), neither of whom found a single male in examination of thousands of roaches throughout the United States, Mexico, and the West Indies. Males are quite common here, however, as evidenced by the large number in the Orthoptera collections of the Entomology Department of the University of Hawaii.

The adult female roach is described by Hebard (1917) as follows:

> Form robust, structure rather heavy. Head flattened, eyes well developed. Maxillary palpi short and stout. Pronotum with glabrous surface, showing minute, rather widely spaced pits. Wings transparent except in narrow area of the irregular costal veins and distal portion of anterior field where they are translucent. Styles very short, joints much fused, accuminate tip flattened, dorsal surface weakly convex, ventral surface more strongly convex proximad. This species is easily separated from the other common cockroaches of North America by having the ventral margins of the femora unarmed, or supplied with distal spines. Head shining, blackish-brown; legs brown; tegmina translucent, blackish chestnut brown. Abdomen with dorsal surface dark brown [varies considerably; may be margined with white or dark bands], ventral surface polished, broadly margined with blackish-brown... [various shades of brown have been observed]. Pronotum shining, blackish-brown, with marginal traces . . . [buff colored] latero-cephalad.

For field identification, the adult male may be distinguished from the female in that its wing covers completely cover the abdomen, while those of the female do not.

The mode of reproduction of *Pycnoscelus surinamensis* was previously unknown; several contradictory concepts being recorded in the literature, all apparently based on inadequate observations. To help clarify this situation, a large number of adult female

roaches were housed individually in the laboratory and periodically examined several times a day. The resultant observations coupled with those made in the normal habitat of the roach are herein presented.

The female Surinam roach forms an egg case about the individual eggs. The ootheca is carried internally during the period of gestation and is deposited or carried externally only under such unusual conditions as are outlined below. Normally reproduction is ovoviviparous, the nymphs hatching within the body of the female. Gravid females have on occasions, however, been observed in the soil with egg cases protruding from the ovipositor. Deposition of the ootheca may also be induced in the laboratory in some instances by excitation of the female. E. W. French reports (personal communication) that one small female deposited an egg case while in confinement and twenty-five days later deposited another. No egg cases thus obtained hatched under laboratory conditions, verifying the results of similar attempts by Zappe (1918).

Birth of living young has been observed a number of times by the author, usually at night or when the gravid female was kept in the darkness. It is accompanied by extreme nervousness on the part of the female, which becomes very excited, strains and distends her ovipositor enormously in attempting to expel the new born nymphs and the remainder of the egg case. She will frequently double up and drag the tip of the abdomen. They have been observed to grasp fragments of the ootheca with the hind limbs to facilitate extrusion. The size of broods born in the laboratory varied from thirty to thirty-six nymphs. On one occasion thirty-six hours elapsed between the birth of the first and last nymphs of a brood.

In *P. surinamensis* the egg case lies in the body of the female with the double row of embryos in a horizontal position, in contrast to the vertical position of the egg case of *Periplaneta americana* (Linn.) and other roaches. When accidentally deposited or dissected from the gravid female, the egg case is light cream in color, turning buff to tan upon exposure to the air. Those observed have not hardened, unlike those of oviparous roaches, and are therefore very susceptible to damage.

The ootheca consists of two rows of alternately spaced segments, each housing an embryonated egg. Between thirty and thirty-six segments have been counted on specimens studied, a range which corresponds to the number of nymphs per brood born in the laboratory. The egg case measures approximately 9 mm. by 3.5 mm. by 2.5 mm. Embryos dissected from the eggs were well advanced in development and their appearance was much the same as that of the new born nymphs described below.

The nymphs when born are a translucent white with orange-brown mandibles and spines, and are approximately 4.5 mm. in length. The head measures 1.1 mm. wide and 0.6 mm. long and the eye spots are darker than the remainder of the head. The

exoskeleton begins to harden upon exposure to the air and in 5 to 6 hours it is a glossy mahogany brown, the ventral surface and legs still remaining translucent. The fragments of the ootheca extruded by the female are usually devoured by the nymphs soon after birth.

SUMMARY

Observations on the habitat, mode of reproduction, and habits of *Pycnoscelus surinamensis*, the intermediate host of the chicken eyeworm in Hawaii, have been presented, with notes on the appearance of the egg case and the new born nymphs.

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The Genus Spathomeles Gerstaecker, with the Description of a New Species from Borneo (Coleoptera: Endomychidae)

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(Presented by Mr. Zimmerman at the meeting of June 14, 1948)

Among a lot of Endomychidae submitted to me for study by Mr. Elwood Zimmerman of the Bernice P. Bishop Museum is a specimen representing an undescribed species of *Spathomeles.* In describing this form I have thought the occasion opportune for presenting a modern synopsis of the genus. The species are not numerous nor is identification difficult but a concise review of the genus will bring together several isolated descriptions.

The genera *Amphisternus* Germar and *Spathomeles* Gerstaecker are the most highly derived of the Eumorphinae, the latter especially showing very strong sexual differentiation. Both these genera agree in having the mesosternum transverse and the metasternum tumid on each side, although this latter feature is variable from species to species. *Spathomeles* differs from *Amphisternus* in having the apex of the prosternal process entire (forked in *Amphisternus*), and in the chisel-shaped apex of the mandible (minutely bifid in *Amphisternus*). In both genera the less derived species have a muricate, unpunctured and opaque or glossy surface; the more highly derived species have the surface shining and punctured. In each genus there are species intermediate between these two conditions, e.g. *S. elegans* Gorham, in which the pronotum is finely muricate, the elytra shining and punctured.

With the exception of *S. bonthainicus* Heller, of which I have seen no specimens, I have studied the taxonomy by use of several structural features, including the aedeagus. This last structure, while it shows marked specific differences, is not necessary for identification. In fact, external features may exhibit sharper divergence. I have, nevertheless, included outline drawings of the aedeagi because of the unusual, even gargantuan, development of this organ.

The order in which the species appear in the key is merely one of convenience; the subsequent treatment gives the apparent degree of derivation.

GENUS SPATHOMELES GERSTAECKER

Spathomeles Gerst. 1857. Archiv. Naturgesch. 23 : 218

Cacodaemon Thomson 1857 (in part). Archives Entomol. 1 : 154.
Rachidophorus Guérin 1857 (in part). Archives Entomol. 1 : 581.
Genotype: *Spathomeles anaglyptus* Gerstaecker.

KEY TO THE SPECIES

1.	Pronotum without evident punctures, muricate	2.
	Pronotum punctured, shining, with discal impressions	4.
2(1).	Pronotum with discal impressions ..... **elegans** Gorham (p. 440)	
	Pronotum without discal impressions, its surface even	3.
3(2).	Elytra with weal-like yellow spots ..... **turritus** Gerstaecker (p. 438)	
	Elytra with a reddish reticulum ..... **retiarius** sp. n. (p. 438)	
4(1).	Pre-apical elytral marking a transverse, serrate band	5.
	Pre-apical elytral marking a rounded spot	6.
5(4).	Metasternum with a strigose pit at middle of front ..... **decoratus** Gerstaecker (p. 441)	
	Metasternum without distinct median pit ..... **dohrnii** Gerstaecker (p. 440)	
6(4).	Middle elytral spot weal-like or moderately tumid	7.
	Middle elytral spot on a high, conical elevation ..... **darwinista** Dohrn (p. 442)	
7(6).	Base of hind tibia of male with a strong tooth ..... **anaglyptus** Gerstaecker (p. 442)	
	Hind tibia of male without tooth ..... **bonthainicus** Heller (p. 440)	

Spathomeles retiarius sp. n. (Figs. 1, 2).

Smaller than any hitherto described species and very different in color pattern. Instead of the tumid, yellow spots of other species the elytral markings of *retiarius* consist of a reticulum of reddish color not at all raised above the elytral surface, and not very sharply contrasted with the ground color but nevertheless distinct. General color blackish-brown with violaceous reflections, surface muricate, unpunctured, softly glossy. Head rugose between the antennal bases and with a broad impression on each side. Antennae slender, third joint about half as long again as fourth, club very large and strongly flattened. Pronotum decidedly transverse, its front angles produced and acutely rounded, its hind angles acutely but briefly produced. Basal transverse stria deep, lateral striae short and feeble. Elytra short and highly convex, apices subtruncate. Each elytron is elevated before its middle into a high spine. This spine is very broad at its base, suddenly narrowed at mid-height and there bent abruptly backward and inward. Femora strongly clavate. Tibiae, especially the front ones, curved and with a dense tuft of golden hairs at apex. The middle tibia bears a minute tubercle on its inner face at distal two-thirds of length. Prosternal process narrow between the front coxae, considerably prolonged, smooth, narrowly rounded at apex. Metasternum smooth at middle, with a deep fovea on each side near its front margin. Last abdominal sternite sinuately emarginate. Length 8.5 mm.

Type material: one male, holotype, Sandakan, British North Borneo, December, 1926, Pemberton coll.; Bishop Museum collection.

This species is clearly annectant to *Amphisternus* but presents the critical features of *Spathomeles*.

Spathomeles turritus Gerstaecker. 1857. Archiv Naturgesch. 23 : 220.

Spathomeles turritus Gerstaecker. 1858. Monographie der Endomychiden, p. 67.

The male is generally similar in contour to the previous species but the elytral spines are erect, reflexed slightly at their tips. Pronotum without discal impressions, its surface finely muricate, its

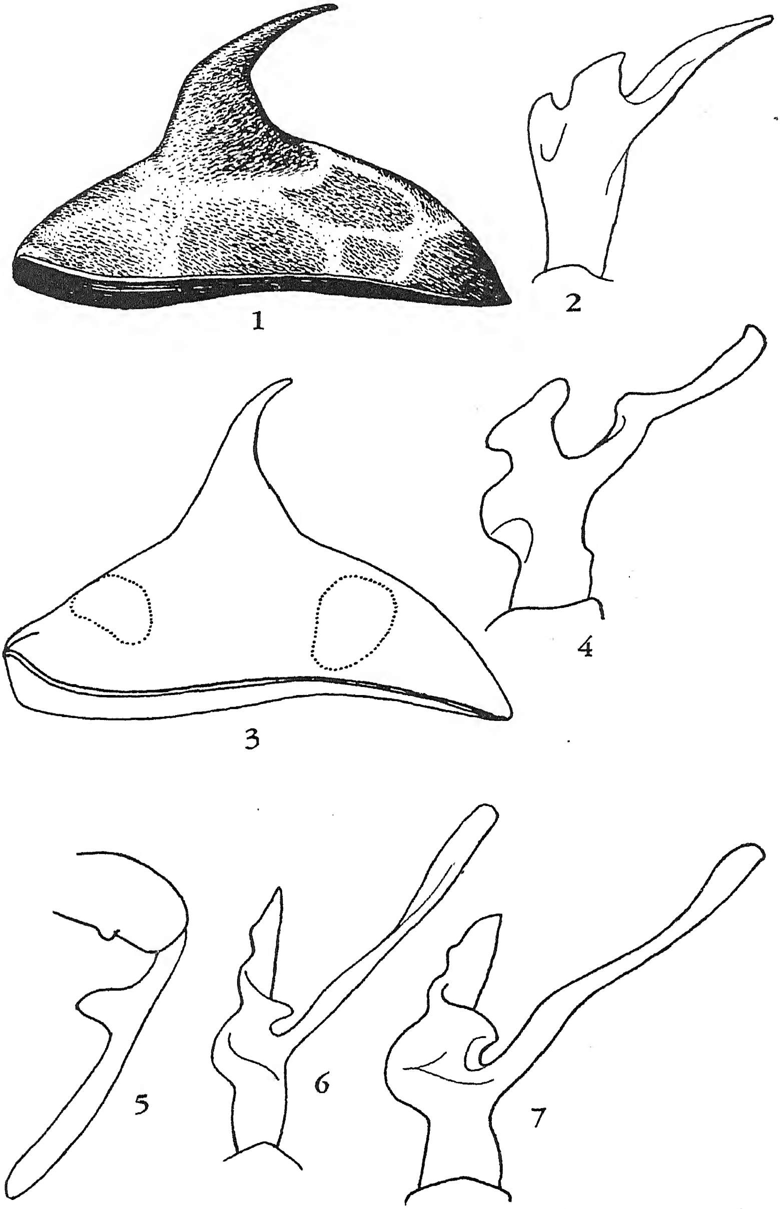

Figure 1. **Spathomeles retiarius** sp. n.: left elytron of male (type), side view.
Figure 2. **Spathomeles retiarius** sp. n.: aedeagus of male (type).
Figure 3. **Spathomeles turritus** Gerstaecker: left elytron of male, side view.
Figure 4. **Spathomeles elegans** Gorham: aedeagus of male.
Figure 5. **Spathomeles elegans** Gorham: hind tibia of male.
Figure 6. **Spathomeles decoratus** Gerstaecker: aedeagus of male.
Figure 7. **Spathomeles anaglyptus** Gerstaecker: aedeagus of male.

front angles acutely rounded, hind angles briefly and acutely produced. The elytra (fig. 3) show feeble punctures; wholly black except that each elytron has two weal-like yellow spots, the anterior obliquely placed behind the humerus and externally acuminate, the posterior transversely oval. Femora strongly clavate. Tibiae gently curved, the hind tibia with a low, blunt tooth on inner distal third. Prosternal process a little expanded at tip, metasternum as in *retiarius*. Length 9.5-10 mm. Reported from Penang. The female is unknown.

Frivaldszky (1883: 126) has reported from Borneo a "variety" *dispar*. The only remark of Frivaldszky is that *dispar* lacks the basal elytral spot, and inasmuch as *turritus* does not have a spot on the elytral base the meaning of Frivaldszky's note is obscure.

Spathomeles elegans Gorham 1873. Endomycici Recitati, p. 32.

The following description is based upon the male; females have not yet been reported. Entirely black, excepting two yellow spots on each elytron. Pronotum with surface alutaceous, unpunctured, its front angles bluntly rounded, its hind angles briefly acute. The pronotal disc has a median and two lateral impressions. Elytra moderately shining, distinctly punctured, each elevated at about mid-length into a low, subspiniform tubercle. The anterior spot is posthumeral, the posterior pre-apical. Prosternal process longitudinally grooved. Metasternum as in the preceding two species. Femora strongly clavate, the hind femur with a high, transverse ridge on its posterior surface near apex. Hind tibia (fig. 5) with a large, triangular flange near base. Last abdominal sternite broadly tuberculate. Length 11-12 mm. Reported from Penang and Sumatra.

Spathomeles bonthainicus Heller 1898. Abhandl. Mus. Dresden **7**: 39; pl. 3, fig. 13.

Apparently still known only from Heller's unique type, a male from Mt. Bonthain, Celebes. Black, the elytra with bluish reflections. Each elytron with a low, subspiniform tubercle before the middle and three yellow spots, the first at base near scutellum, the second post-humeral, the third pre-apical. Front femur with a blunt tooth near base. Tibiae curved, the middle tibia subdentate at apical third. Length 11 mm.

I have seen no specimens of this species but Heller's description and figure are adequate for its identification.

Spathomeles dohrnii Gerstaecker 1857. Archiv Naturgesch. **23**: 219.

Spathomeles dohrnii Gerstaecker 1858. Monographie der Endomychiden, p. 64.

Spathomeles dohrni Csiki 1910 (Junk-Schenkling). Cat. Coleopt. pars **12**: 18.

Eumorphus quadrisignatus Guérin 1857. Archives Entomol. **1**: 257, pl. 13, fig. 12.
Rachidophorus quadrisignatus Guérin 1858. Revue et Mag. Zool. (2), **10**: 61.

The most distinctive features of this species are the elytral markings, which consist of an irregular spot at the base and two sinuous or serrate, transverse bands of reddish-yellow color. The second or posthumeral is connected at its inner end with the outer side of the basal spot. Head very thickly punctured between the eyes. Pronotum shining, densely punctured, with a median depression on each side of which is a rounded impression. Front angles obtuse, hind angles slightly acute. Elytra long-oval, blue-black, densely punctate. Prosternal process broad, rough. Metasternum with a deep fovea on each side in front; between these the metasternum has a shallow, roughened impression. The sexes are alike except that the male has the front femur toothed at base, each elytron with a low tubercle and the middle tibia angulately widened at its distal two-thirds. Reported from Sumatra and Java.

Spathomeles decoratus Gerstaecker 1857. Archiv Naturgesch. **23**: 31.
Spathomeles decoratus Gerstaecker 1858. Monographie der Endomychiden, p. 66.
Spathomeles ornatus Gorham 1886. Proc. Zool. Soc. London, p. 155.
Spathomeles decoratus var. *ornatus* Gorham 1896. Ann. Mus. Civ. Genova ser. 2, **16**(36): 292.
Spathomeles decoratus Arrow 1925. Fauna Br. India: Col. Erotylidae etc., p. 308, fig.
Cacodaemon hamatus Thomson 1857. Archives Entom. **1**: 157.
Rachidophorus latreillei Guérin 1858. Revue et Mag. Zool. (2) **10**: 61.

Usually each elytron of this species has an oval, yellowish spot near the scutellum, two spots transversely placed before the middle and a pre-apical bar, transversely placed. In some specimens the two middle spots are coalesced (var. *ornatus* Gorham) but this variation is not correlated with geography or ecology so far as known at present. More rarely the pre-apical bar is divided. The inner of the two posthumeral spots encloses a low, subconical elevation. In the male the front femur is toothed near its base, the middle tibia is toothed at its distal third and the hind tibia may have a tooth near its base. The development of the tooth of the hind tibia is variable, ranging from a feeble tubercle to a decided spine. Length 11.5-12.5 mm. Reported from Java (?), Malay Peninsula, Burma and Assam.

In this species and those following the elytral spines of the males are slender, distinctly recurved and longer than in *elegans, dohrnii* and *bonthainicus* but much smaller than in *retiarus* and *turritus.*

Spathomeles anaglyptus Gerstaecker 1857. Archiv Naturgesch. 23: 219 idem. 1858. Monographie der Endomychiden, p. 62, pl. 2, fig. 2.

Cacodaemon Hopei Thomson 1857. Archives Entom. **1**: 154.

Eumorphus Hopei Guérin 1857. Archives Entom. **1**: 255.

Rachidophorus Hopei Guérin 1858. Revue et Mag. Zool. (2) **10**: 59.

The best characters for distinguishing this species have been set forth in the key. The development of the long spine on the hind tibia of the male is apparently constant. The degree of elevation of the middle elytral spot is variable. In specimens from Malacca the elevation is subconical, its highest part about level with the elytral suture when viewed from behind. In the Sumatra specimens at hand this elevation is roundly tumid, in Borneo specimens merely weal-like.

The elytral spines of the male are slender, recurved and subacuminate. The front femur is toothed at base, the front tibia somewhat expanded at apex. The middle tibia is angulately toothed at distal third and clothed there with a dense brush of setae. The metasternum has a very deep, strigose pit at the middle of its front margin. Length 12-13 mm. Range: Malacca, Penang, Sumatra, Java?.

Spathomeles anaglyptus insuspectus Gorham.

Spathomeles insuspectus Gorham 1873. Endomycici Recitati p. 31.

Differs from nominate *anaglyptus* in the larger size of the elytral spots. The basal and middle spots are approximate and coalesce in some specimens. The middle spot is feebly elevated. Occurs in Borneo.

Spathomeles darwinista Dohrn 1873. Stettiner Ent. Zeitung, p. 322.

Spathomeles pyramidalis Gorham 1873. Endomycici Recitati, p. 31.

This is clearly the most derivative of the species. In viewing series of *anaglyptus* from various localities and of *darwinista*, one might suppose that a single Rassenkreis was represented but the form of *anaglyptus* occurring in Borneo is less similar to *darwinista* than is nominate *anaglyptus* from farther south. While closely related, *darwinista* differs from *anaglyptus* in several features. The elytral spots are much smaller and the middle spot encloses a high, conical elevation (fig. 9). The elytral spines of the male are more decurved and longer and the hind tibia is feebly toothed or, more often, simple. The front tibia (fig. 11) is very broadly expanded at its apex and deeply excavated on its inner margin. The aedeagus of *darwinista* (fig. 10) shows the greatest degree of development in the genus. The median mesosternal pit is also greatly developed.

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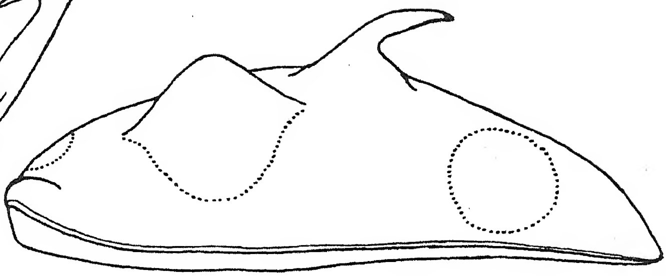

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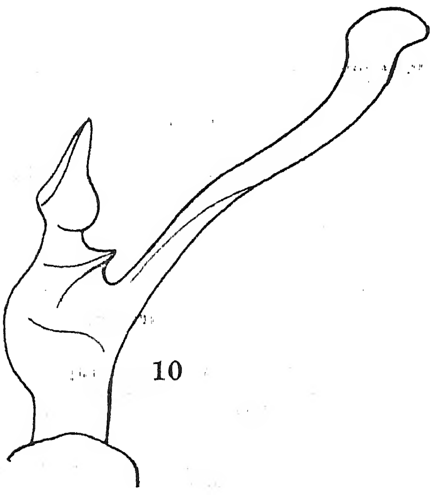

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Figure 8. **Spathomeles anaglyptus** Gerstaecker: hind tibia of male.
Figure 9. **Spathomeles darwinista** Dohrn: left elytron of male, side view.
Figure 10. **Spathomeles darwinista** Dohrn: aedeagus of male.
Figure 11. **Spathomeles darwinista** Dohrn: front tibia of male.

Apparently this pit is accessory to the two deep foveae of the mesosternum, which are likely glandular in function. Several collectors have remarked that various species of Oriental Endomychidae exude strong-smelling fluids when disturbed.

The length of the present species is 12-13 mm. It has been reported from the Philippines. More definite are the labels on four of the specimens at hand: "Surigao, Mindanao."

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Synonymy of Hypocryphalus mangiferae (Stebbing) and its Occurrence in Hawaii (Coleoptera: Scolytidae)

By O. H. SWEZEY

(Presented at the meeting of May 10, 1948)

Among specimens of Scolytidae sent to the Division of Insect Identification, U. S. Bureau of Entomology and Plant Quarantine, in February and March, and studied by Dr. W. H. Anderson, were some beetles which he determined as *Hypocryphalus mangiferae* (Stebbing). The specimens of this species studied by Dr. Anderson at that time were six reared from mango scions at the Foster Gardens, Honolulu, September 19, 1931, by Dr. H. L. Lyon, and four which were collected at light in Manoa Valley, Oahu, February 12, 1940, by E. M. Ehrhorn. The identification was by comparison with specimens of *mangiferae* already present in the U. S. National Museum collection. I had previously tentatively determined these, and so labelled them as *Hypothenemus griseus* Blackburn (1885), a species described from a single specimen on poppy, and apparently never taken since. The later records of *H. griseus* noted by me (Proc. Hawaiian Ent. Soc., **11**: 119, lines 8-10) should all be deleted, since they really refer to *H. mangiferae.*

On my mentioning the difficulty of finding *mangiferae* in the literature, Dr. Anderson kindly supplied the following synonymy and bibliography:

Hypothenemus sp., Stebbing, Indian Museum Notes **6**: 68, 1903 (India).

Cryphalus (*Hypothenemus*) *mangiferae* n. sp., Stebbing, Indian Forest Insects: 542-543, 1914 (India).

Dacryphalus (*Cryphalus*) *mangiferae* (Stebbing). Hopkins, Bull. Ent. Research, **18**: 28, 1927 (Apia, Samoa).

Hypocryphalus mangiferae n. sp., Eggers, Inst. Biol. (Sao Paulo) Arquivos, **1**: 85, 1928 (Brazil).

Cryphalus (*Hypocryphalus*) *mangiferae* Stebbing. Beeson, Insects of Samoa, **4**: 226, 1929 (Apia, Samoa).

Hypocryphalus mangiferae (Stebbing). Eggers, Wiener Ent. Zeit. **47**: 185, 1931.

Hypocryphalus mangiferae (Stebbing). Beeson, Jour. Fed. Malay States, **18**: 288, 1938.

Hypocryphalus mangiferae (Stebbing). Beeson, B. P. Bishop Mus., Occ. Papers, **15**, no. 18: 198, 1940 (Mangareva Id.).

There are no records of the capture of *mangiferae* in Hawaii aside from those mentioned above, so it is not known if the species is well established and widespread; it seems that if it were, more of the local entomologists would have collected it. In India it is recorded as boring into the living mango twigs, and hence it is rated as injurious. It would be well to be on the lookout for its presence in mango trees in Hawaii.

Proc. Hawn. Ent. Soc., Vol. XIII, No. 3, March, 1949.

It is widely distributed as is seen from the above bibliography: India, Samoa, Mangareva Island, Brazil and now Hawaii.

Note: In a letter Dr. Anderson has expressed his belief that *Ericryphalus henshawi* Hopkins is a synonym of *Ericryphalus sylvicola* (Perkins); and that *Cryphalus swezeyi* Schedl belongs in the genus *Ericryphalus*.

War-Time Dispersal of Pacific Island Nysius (Hemiptera: Lygaeidae)

By ROBERT L. USINGER
University of California, Berkeley

(Presented by Mr. Zimmerman at the meeting of May 10, 1948)

Species of the genus *Nysius* occur on most of the islands of the world, the most noteworthy exceptions being the islands of central and southeastern Polynesia. A high degree of endemicity is exhibited by these species, even on low islands such as Jarvis Island, Wake Island, and the leeward islands of the Hawaiian archipelago; therefore, it would appear that the group is readily dispersable, highly adaptable, and quite variable.

Attention was called to an apparently immigrant species, *Nysius caledoniae* Distant, on Guam (Usinger, B. P. Bishop Mus. Bull. **189**: 28, 1946). World War II greatly increased the chances of dispersal of Pacific Island insects. As might be expected, several species of *Nysius* were distributed during this period. New records which have come to my attention are recorded at this time as an aid to future students of insular speciation.

1. *Nysius terrestris* Usinger, 1942. Hawaiian Islands. New record: Johnston Island, May 1, 1946 (N. L. H. Krauss) sent for determination by E. C. Zimmerman.
2. *Nysius pulchellus* Stål, 1859. Guam. New record: Eniwetok Atoll, May 13, 1946, on *Portulaca* (R. G. Oakley), determined by R. I. Sailer.
3. *Nysius picipes* Usinger, 1937. Wake Island. New records: Engebi Island, Aomon and Japtan Island, Eniwetok Atoll, May 15 to 18, 1946 (R. G. Oakley and Henry Townes), sent for determination by R. I. Sailer.

Notes on Parasites of Agonoxena argaula Meyrick

By R. H. VAN ZWALUWENBURG

(Presented at the meeting of October 11, 1948)

The finding of *Agonoxena argaula* Meyrick attacking various palms in Honolulu late in June, 1948, by C. E. Pemberton and the writer, adds another to the list of insects attacking coconut palms in Hawaii. This agonoxenid moth is a native of Fiji, Samoa and the Ellice Islands, and was recently found to be established on Palmyra Island. It is believed to have been present on Oahu for at least two years, but escaped attention because of confusion of its damage with that caused by the native pyralid, *Omiodes blackburni* (Butler). The *Agonoxena* larva is greenish yellow and feeds on the epidermis of the under leaf-surface beneath a fine web; it does

not tie the edges of the leaf together as *Omiodes* does. At first the feeding scar is confined to a long, narrow area, but later this is expanded into an irregular blotch. Pupation takes place beneath a tight oval web, usually on the underside of the leaf. The egg of this moth is not known.

J. S. Rosa and the writer soon found that *Agonoxena* is attacked by two parasites already known here: *Zaleptopygus* (*Cremastus*) *flavo-orbitalis* (Cameron) and *Brachymeria polynesialis* (Cameron). The combined parasitism of these species is usually high, and it seems improbable that *Agonoxena* will ever become a serious pest here. However, the accumulated feeding over a period of some two years, which is about the length of time any one coconut frond persists on the tree, gives the trees an unsightly appearance, even though the *Agonoxena* population is never high at any one time.

Through the cooperation of Blair Menardi of Tutuila, American Samoa, a shipment of parasitized *Agonoxena* material was made to Honolulu in August, 1948. From this were reared one individual of *Apanteles agonoxenae* Fullaway, and four adults of a *Brachymeria* which D. T. Fullaway, who identified all the parasites from the Samoan material, reports to be an undescribed species. The following refers to this new *Brachymeria,* which was bred in the laboratory by Mr. Rosa and the writer.

Only one female survived from the Samoan material; confined for a day or two with males from the same source, she lived in the laboratory for 54 days. Prepupae or freshly formed pupae of *Agonoxena* were exposed to the female (the first when she was four days old) every few days, as field material was available. During her life this female produced seven males and nine females. Her first progeny was a male which issued 14 days after she was observed (when seven days old) to oviposit in a host pupa. The average time between oviposition and emergence of the adult progeny was between 14 and 15 days, with evidence that males require slightly less time for development than females. The average mean temperature during the period involved was 79.1 degrees F. A second generation male *Brachymeria* survived 37 days in the laboratory. Eleven *Brachymeria* (eight females and three males) reared from the original Samoan female were released at Kaalawai, Honolulu, August 23 and September 8, 1948. No field recoveries of the parasite have yet been made.

A New Dynatopechus Weevil Injuring Lima Beans in Hawaii (Coleoptera: Curculionidae: Cossoninae)

By ELWOOD C. ZIMMERMAN
Experiment Station, H.S.P.A.

With a Description of the Larva

By W. H. ANDERSON
United States Bureau of Entomology and Plant Quarantine
Washington, D. C.

(Presented at the meeting of December 13, 1948)

Part I. The Adults

By ELWOOD C. ZIMMERMAN

The peculiar weevil genus *Dynatopechus* was erected by Sir Guy Marshall in 1931 (Insects of Samoa 4[5] : 325) to receive a new species from Samoa and *Amorphocerus aureopilosus* Fairmaire from Tahiti and Fiji. The genotype, *D. rubronotatus* Marshall, is known only from the unique female holotype (from Apia, Upolu) now in the British Museum. Fairmaire's species is recorded only from the type series described a century ago (Revue et Magasin de Zoologie, p. 73, 1849) from specimens found by Vesco to be rather common in the beans of *Erythrina* in Tahiti, and from a series collected at Oneata, Lau, Fiji, August 18, 1924, from a pod of *Erythrina indica* by E. H. Bryan, Jr. This series was identified from the description by Marshall, and it evidently formed the basis of his Fijian record in his 1931 report. According to a letter from Marshall, Fairmaire's type may have been in the Godeffroy collection in the Hamburg Museum which was destroyed during the war.

In January, 1940, George Callaghan, U. S. Bureau of Entomology and Plant Quarantine, intercepted a species of the genus in a curio containing seeds of *Leucaena glauca* ("koa haole") being mailed from the Honolulu post office. In September, 1940, three examples were intercepted in seeds of *Adenanthera pavonina* by Territorial Board of Agriculture and Forestry quarantine inspectors in a package mailed to Honolulu from Kyoto, Japan. The origin of the seeds is unknown, but they may have been sent from the tropical Pacific to Hawaii by way of Japan. Following the first interception, U. S. Bureau of Entomology and Plant Quarantine inspectors found other curios containing the following seeds infested: *Canavalia* ("mauna loa"), *Mucuna urens, Mucuna gigantea, Dioclea violacea, Coix lacryma-jobi* (Job's tears) and more *Leucaena glauca* seeds. Most or all of the infested curios were made in Honolulu and on the island of Hawaii, but no definite informa-

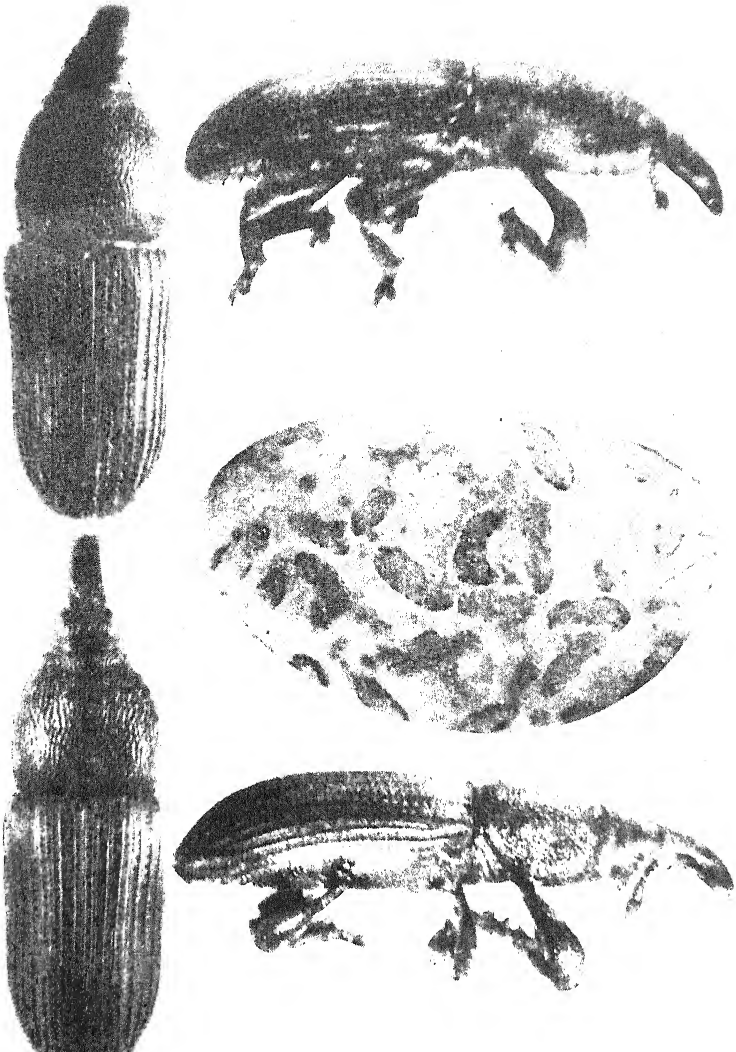

Figure 1.—Photographs of adults of *Dynatopechus* and a lima bean showing pupal cells of *D. calandrodes* Zimmerman. Dorsal and lateral views of *D. aureopilosus* (Fairmaire) at top and *D. calandrodes* Zimmerman at bottom. Each weevil is 4.5 mm. long overall; the bean is 25 mm. long. (Photographs by J. T. Yamamoto.)

tion as to the origin of the infested seeds could be obtained, although it was assumed that they were grown in Hawaii. Special searches were made on Oahu to find the weevils infesting various seeds in the field, but no infestations could be found. In June, 1947, a second species of the genus was intercepted by quarantine inspectors at the Honolulu post office in *Canavalia* seeds in a curio being sent to the Mainland. No records of these interceptions were made in these "Proceedings," for it could not be determined that the weevils were established and breeding in Hawaii, because curios, and possibly bulk seeds, were being imported to Hawaii from Samoa, Tahiti, Fiji and Micronesia by curio manufacturers and travelers.

In the fall of 1948, Mrs. Zimmerman called my attention to several *Dynatopechus* weevils in a green lima bean pod picked in our garden. An inspection revealed that almost every pod of our lima beans which had been broken by the attack of the bean lycaenid butterfly (*Lampides boeticus* [Linnaeus]) contained one to several weevils. Undamaged green pods were not infested. A number of the weevils were placed with some dried lima beans which soon became heavily infested with larvae. A large number of adults were reared in a few weeks. Subsequent inspection showed a heavy infestation of the dried beans hanging on the vines. It appears that as soon as the pods dry and split open, the weevils enter the pods and eat their ways into the beans, where the eggs are deposited. The adult weevils enter the beans by gnawing through the seed scars, or through breaks in the seed coat, and the infestation results in hulls full of frass and evacuated pupal chambers. Large numbers will develop in a single lima bean seed. The seeds are, of course, destroyed.

From information now available, it is known that *Dynatopechus* weevils may develop into pests of economic importance when introduced into new areas. The new species described here has been observed to infest heavily lima beans on the vine and to destroy the seeds, and several generations have been reared on dried lima beans in storage. It would appear advisable, therefore, that the spread of these weevils to new areas be stopped, if possible. A ban on the shipment to the mainland United States of unfumigated leis and other curios containing leguminous seeds is suggested. Also, it is recommended that such seeds being imported to Hawaii from Pacific islands, whether in bulk or in curios, be fumigated or confiscated and destroyed. Although the *Dynatopechus* weevils heretofore have been known only to a few museum workers, and have remained practically unknown in their tropical island haunts, we now know that there are several species in the genus, that they are seed-eaters, and that they are potential pests.

Dynatopechus weevils belong to a subfamily whose members characteristically are feeders under dead bark and in dead wood and are useful in returning dead plant material to the soil. *Dynatopechus* has an unusual and unexpected habit for the group. Another

peculiarity is its remarkable similarity to the *Calandra* (*Sitophilus*) grain weevils, with which they may be confused easily unless examined carefully. As a matter of fact, at least one infestation of *Dynatopechus* intercepted in quarantine at Honolulu was determined as *Calandra oryzae* by an entomologist of long experience. Some *Dynatopechus* have red markings on the dorsum quite like those on some *Calandra*, and they are about the same size, coloration and general appearance. This apparent "mimicking" of *Calandra* by *Dynatopechus* is a most interesting phenomenon. Another unusual feature of these weevils is the peculiar sculpture of the elytra which is somewhat like that of *Calandra*, but the punctures are less coarse and the intervals and striae are more distinct. As Marshall noted in his original generic description, and with his characteristic acuteness of observation, the first three striae are carinate on their *outer* edges, whereas the other intervals are carinate on their *inner* edges.

Calandra weevils are easily distinguished from *Dynatopechus*, because on *Calandra* the pygidium is exposed and conspicuous from above, and the antennae, which are inserted very close to the eyes, have six-segmented funicles instead of five-segmented ones—to mention only a few of the characters which can be noted easily by those unfamiliar with these weevils.

The description which follows is that of one of the two species of *Dynatopechus* known to be established in Hawaii. New information on the second species (the one heretofore most frequently intercepted in curios in Honolulu) has come to hand while these "Proceedings" were in proof, hence a discussion of that species will be delayed until a second report can be written. It is not *aureopilosus* as determined earlier.

Dynatopechus calandrodes Zimmerman, new species (figs. 1, 2, 3).

Derm mostly dulled by reticulation, piceous to black with the appendages more diluted with red; each elytron with a variable, basal, reddish patch across intervals three to six or seven inclusive, and another variable reddish patch at and behind middle extending across intervals three to five inclusive, or only on intervals four and five or extending onto six, these reddish patches commonly connected longitudinally along intervals three and four, and the red color may extend back onto declivity; sides of disc of pronotum usually with variable reddish coloration, but less definite than elytral markings.

Head coarsely and densely punctate above, punctures smaller and less dense only on the basal area; interocular area broadly flattened in both sexes, without a median fovea, approximately twice as broad between eyes as breadth of an eye as measured from front, punctures deep, coarse, tending to form a reticulate pattern or, apically in male, tending to be longitudinally confluent with those on base of rostrum; eyes measured from side, slightly longer than distance between their hind margins and pronotum; under-surface punctate and with transverse striae.

Rostrum, from front margin of an eye to apex of epistome (not apex of mandibles), two-thirds as long as pronotum in both sexes; longitudinal dorsal contour, as viewed from side, evenly arcuate from top of head to apex, except for the slight flattening at the interocular area; distinctly broader and heavier in male than female; densely set with longitudinally confluent punctures in male from base to apex; female with small punctures beyond antennae and moderately shiny.

Antennae with scape distinctly more angulate and strongly clavate in male than female (see drawings); first funicular segment as long as broad, twice as long as two which is transverse, three, four and five each more strongly transverse, five twice as broad as long; club as long as funicular segments two to five inclusive (funicle and club similar to Marshall's figure of *rubronotatus*, but with a small fourth segment to club which is not indicated in Marshall's figure).

Prothorax slightly broader than long (34:32 on holotype, 32:29 on allotype), broadest just behind middle; base distinctly sinuous; sides just in front of postero-lateral angles sharply, narrowly incised by the impressed line which extends from sternum, thus the postero-lateral angles sharply tuberculiform (as viewed from above), the development of the protuberance variable, usually more strongly developed on males and rather inconspicuous on some females; sides evenly arcuate to the strongly, sharply incised subapical constriction, the constriction continued across disc as an impressed line, the area in front of the constriction collar-like; longitudinal dorsal contour evenly arcuate from base to subapical constriction; densely, coarsely, subconfluently and confluently punctured, intervals narrower than punctures and forming a reticulate pattern, some examples with a vague indication of a median line; punctures bearing short, golden, prostrate setae which are not very conspicuous.

Elytra subparallel-sided in basal two-thirds, jointly rounded at apex, not quite twice as long as broad, a little more than twice as long as prothorax (measured from side), longitudinal dorsal outline discontinuous with that of pronotum; intervals flat on disc (except for carinate edges) and there wider than striae, shallowly punctate, the punctures bearing mostly rather inconspicuous, prostrate, golden setae; striae with chain-like punctures bearing inconspicuous, golden setae; intervals and striae blending in the lateral and caudal areas with the carinate edges of the intervals alone appearing as cariniform intervals and the punctate part of the intervals together with the striae appearing as broad striae; carinae of intervals strongly developed throughout and especially elevated and prominent on the declivity.

Legs coarsely, densely punctate, punctures longitudinally confluent on tibiae and apically on femora; femora sexually dimorphic, shaped as illustrated.

Underside densely and rather coarsely punctured throughout; prosternum with subapical constriction deeply impressed throughout, intercoxal process about eight-tenths as broad as a fore coxa, distance from fore coxal cavity to fore margin three times as long as distance from hind margin of fore coxal cavity to hind margin of prosternum; an impressed line across prosternum just behind coxae to dorsum; metasternum with shortest distance between mid and hind coxae twice as great as greatest antero-postero chord of a metacoxa; venter with disc of first segment flattened in female, but broadly, shallowly concave in male, segments three and four with numerous punctures across entire breadths, male with disc of segment five differentiated in elevation from sides and with the setae of the punctures modified into longer, fine, erect, conspicuous hairs.

Length: 2.75-3.5 mm.; breadth: 1.0-1.25 mm.

Holotype male, allotype female and a long series of paratypes reared by me from lima bean seeds (*Phaseolus limensis*) taken in my garden at Manoa Valley, Honolulu, in October, 1948. The holotype and allotype are in the Bishop Museum, Honolulu.

Sir Guy Marshall has kindly compared specimens of this new species with his unique female type of *D. rubronotatus*, and he reports that his species differs by its having the "rostrum shorter, stouter and less curved; eyes rather less convex, punctures on the vertex much finer; prothorax subconical, being widest quite close

to the base and much more rapidly narrowed in front, the apical constriction markedly shallower, punctures on the disk small and separated (not confluent), as also are the punctures on the head and rostrum; elytra with the punctures duplicated on the basal half of interval 2 and the basal fourth of interval 3."

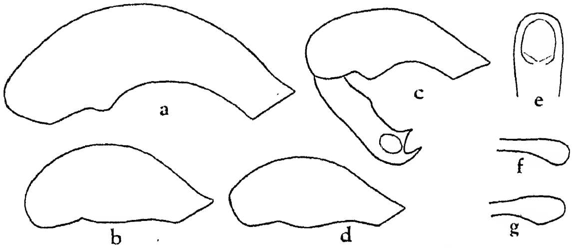

Figure 2.—Features of *Dynatopechus*. **a,** fore femur of male *aureopilosus* (Fairmaire); **b,** the same, female; **c,** fore femur and tibia of male *D. calandrodes* Zimmerman (the angle between uncus and mucron of tibia varies somewhat according to angle of view); **d,** fore femur of female *D. calandrodes;* **e,** apical part of aedeagus of *D. calandrodes* (apical setae omitted); **f,** antennal scape of female *D. calandrodes,* and **g,** the same of the male.

The new species appears to be closely allied to *aureopilosus,* and it closely resembles that species. It is, however, obviously a more coarsely punctured species than is *aureopilosus,* and a comparison of the sculpture of the pronotum alone provides an easy and quick way of separating the two species. The longitudinal dorsal contour of pronotum and elytra of *aureopilosus* are more nearly continuous than that of the new species. The pronotum of *aureopilosus* commonly has an impunctate median line, and is reddish with a broad, median, black stripe. The differences in the shapes of the fore femora are indicated by the drawings. The apex of the aedeagus of *aureopilosus* has a small, more heavily sclerotized, triangular point at the middle of the apical rim which is absent in *calandrodes.*

As noted above, I have reared this species through several generations on dried lima beans. No detailed studies have been made on its host range, or on its life history. A few notes, however, have been assembled. The first specimens of the species taken in Honolulu were intercepted on June 19, 1947, by a quarantine inspector who found them infesting *Canavalia* seeds in a curio mailed from the Waikiki post office, Honolulu. I have obtained reproduction in dried seeds of purple hulled cowpea (*Vigna sinensis*) and mung bean (*Phaseolus aureus*). The adults fed on dry, very hard field corn ("Guam" variety), but I observed no reproduction. The mung beans are so small that the larvae fed from the outside of the beans and were found loose in the sample of beans artificially infested. The exact length of the life cycle was not determined, but it is less than six weeks.

Part II. Description of the Full-grown Larva of Dynatopechus calandrodes Zimmerman

By W. H. ANDERSON

Approximately 3 mm. long; head 0.55 to 0.57 mm. wide. Head free,[1] approximately as broad as long, subcircular, orange-brown, with two narrow but distinct dorsal epicranial non-pigmented stripes which converge posteriorly. Internal epicranial ridge moderately distinct. Anterior ocellus present, small. Accessory sensory appendage of antenna subconical. Frontal suture distinct throughout its length, angulate posteriorly. Endocarina present, slightly less than one-half as long as frons. Frons with four pairs of setae, the setae moderately long, subequal (Fig. B). Epicranium with five dorsal, two lateral and two ventral setae, the dorsal and lateral epicranial setae moderately long, subequal, the ventral setae slightly shorter. Clypeus with setae short, subequal. Anterior margin of labrum smoothly rounded or slightly produced in the middle. Labrum with setae short, subequal, and with three basal sensilla. Labral rods (Fig. E) moderately long, stout, subparallel. Epipharynx with three anterolateral and six anteromedian setae and four median spines. Epipharynx with two groups of sensory pores, each group consisting of four pores, one group in front of the other behind the median spines. Mandible with two apical teeth, without differentiated molar area. Labial palpus (Fig. F) with two articles. Premental sclerite present, with broad posterior median extension. Postmentum with three pairs of setae, the setae of posterior pair separated by a distance subequal to that between those of middle pair. Mala with five ventral and six dorsal setae (Fig. C).

Pronotum (Fig. A) with eleven setae of which ten are moderately long to long, subequal. Thoracic spiracle bicameral, the air tubes subequal in length to diameter of subcircular peritreme. Spiracular area of mesothorax with two setae, one long, the other short. Mesothorax and metathorax with four postdorsal setae, setae 1, 3 and 4 long, 2 short. Pedal area with six setae. Sternum with one pair of elongate setae.

Abdominal spiracles bicameral, the air tubes distinct and annulated, the spiracles oriented so that the air tubes are directed posteriad. Five postdorsal setae present on abdominal segments I to VII, VIII with four, IX with two. Typical abdominal segments with postdorsal setae 1, 3 and 5 long, 2 and 4 short. Seta on pedal area moderately long. Eusternum with the more lateral seta short to very short, the more ventral seta moderately long. Sternellum absent. Anus terminal, not subdorsal. Asperities inconspicuous, short and sparse.

Walls of proventriculus not sclerotized and not set with asperities.

Description based upon larvae collected at Honolulu, October, 1948, in lima bean, E. C. Zimmerman collector. The larvae studied are in the collection of the United States National Museum.

Larvae of *D. calandrodes* are separable from those of the unidentified species of *Dynatopechus* discussed above by Mr. Zimmerman only by careful examination of specimens properly mounted on microscope slides. In larvae of the unidentified species, the setae on frons are obviously shorter (Fig. D), the seta on pedal area of typical abdominal segments is usually distinctly shorter than is the longer seta on pleurum or eusternum of the corresponding segment, and the asperities, particularly on the dorsal folds of the body, are coarser and more numerous. The larvae of the unidentified species studied were collected in leis containing seeds of *Canavalia* sp. from Honolulu, April 7, 1941.

[1] For an explanation of this and other terms used in this description see: Anderson, W. H., "A terminology for the anatomical characters useful in the taxonomy of weevil larvae." Proc. Ent. Soc. Wash., 49: 123-132, 1947.

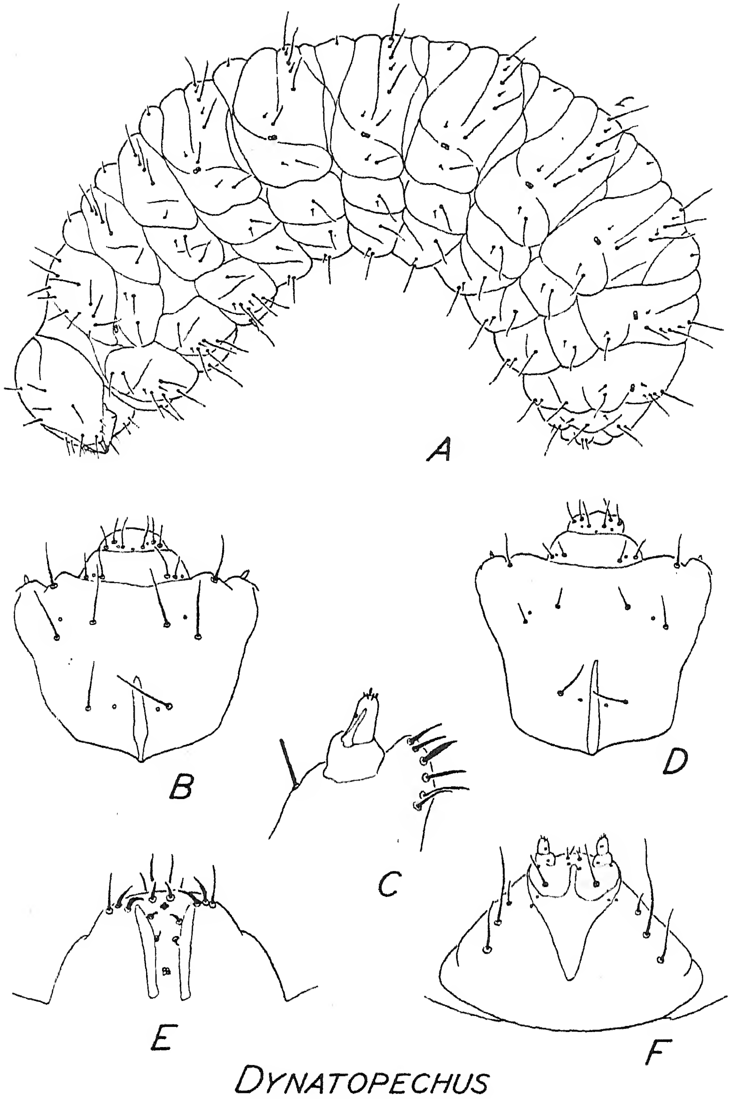

Figure 3.—Features of *Dynatopechus* larvae. A, B, C, E, and F, *Dynatopechus calandrodes* Zimmerman. D, *Dynatopechus,* species not identified. A, larva, lateral view; B, frons; C, mala, dorsal view; D, frons; E, epipharynx; F, labium. (Drawings by W. H. Anderson.)

NEW INSECT RECORDS FOR THE YEAR 1948

Species marked with an asterisk were reported in the Hawaiian Islands for the first time in 1948, on the dates recorded in the text. Those not so marked were observed here prior to that year, but have only now been identified or recorded. For particulars refer to the pages indicated.

CHANCE IMMIGRANTS

BENEFICIAL INSECTS PURPOSELY INTRODUCED

GENERAL INDEX to Vol. XIII

(For plant index see p. 468)

Names marked with an asterisk [*] are described as new on the page indicated in **bold face type.**

PLANT INDEX

ERRATA, VOLUME XIII

Page 15, line 7 from bottom, for "Mauna Kea", read "Mauna Loa".
" 18, line 14, for "(Russel)", read "(Daudin)".
" 26, line 6 from bottom, for "p. —", read "p. 16".
" 27, line 21, for "*Oxytheira*", read "*Oxyethira*".
" 29, line 10 from bottom, for "Stål", read "(Stål)". The same correction should be made on p. 51, line 10 from bottom.
" 46, line 9, for "this not surprising", read "this is not surprising".
" 51, line 13 from bottom, for "*Pycnoscelis*", read "*Pycnoscelus*".
" 82, line 11 from bottom (disregarding footnotes), for "*Euglytatus*", read "*Engytatus*".
" 105, 3rd paragraph, for "Schulz", read "(Schulz)
" 165, line 2 from bottom, for "*oahuensis*", read "*oahuense*".
" 200, line 12 from bottom, for "*Forcypomyia*", read "*Forcipomyia*".
" 201, line 4 from bottom, for "Mueusebeck", read "Muesebeck".
" 203, line 13; "Cameron" should be in Roman letters.
" 205, line 23, for "(Viereck)", read "Viereck". The same correction should be made on p. 317, line 5 from bottom.
" 205, next to last line, for "Fabr.", read "(Fabr.)"; for "singel", read "single"
" 209, line 12 from bottom, for "Hawaiian", read "ornamental South Pacific".
" 212, line 2 from bottom, for "previously seen", read "previously been seen".
" 280, legend for Figure 1, add "*d*, ventral view of ninth tergite and associated structures, and *e*, lateral view of tip of male abdomen, of *Lamproscatella quadrisetosa*; *f*, ventral view of ninth tergite and associated structures, and *g*, lateral view of same, of *Limnellia sejuncta*."

ERRATA NOT PREVIOUSLY NOTED

Vol. VII, p. vii (index), line 16 from bottom in left-hand column, and p. 285, line 8, for "*Solendinia*", read "*Solindenia*".
" X, p. 360, line 14 from bottom, substitute comma for period after "butterfly".
" X, p. 386, lines 3 and 12 from bottom, for "*Ferrisiana*", read "*Ferrisia*".
" X, p. 393, top of page, "Plate XXII" omitted.
" X, p. 394, line 23, for "retangular", read "rectangular".
" X, p. 395, top of page, "Plate XXIII" omitted.
" X, p. 400, line 3, for "7th", read "6th".
" X, p. 401, line 3 from bottom, for "1929", read "1924".
" X, p. 473, line 23, for "Kumuela", read "Kumuwela".
" X, p. 489, line 1, for "Pokakuloa", read "Pohakuloa".
" X, p. 502, line 2 from bottom, for "Mitlh.", read "Mitt.".
" XII, p. 464, line 22, for "aphelinid", read "encyrtid".
" XII, p. 503, line 7, for "10", read "12".
" XII, p. 661, line 10, for "Aphelinidae", read "Encyrtidae".
" XII, p. 668, (index),(under *Frankliniella* add:

Frankliniella 59
flavens 321
fortissima 395
nigripes 538
occidentalis 115, 592
schultzei 538, 593
sp. 14, 24, 62, 66, 69, 71, 115, 120, 123, 126, 130, 329, 396
sulphurea 396, 514